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THE JOURNAL OF BONE AND JOINT SURGERY

8 The Fenway, Boston, Massachusetts

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The Journal of Bone and Joint Surgery

TREATMENT OF FRACTURES OF THE UPPER END OF THE HUMERUS

AN EXPERIMENTAL AND CLINICAL STUDY

BY NELSON J. HOWARD, M.D., AND LEO ELOESSER, M.D.,
SAN FRANCISCO, CALIFORNIA

Stanford Surgical Service of the San Francisco Hospital, San Francisco, California

Eighty-eight cases of fracture of the proximal portion of the humerus have been recorded since 1925 in the files of the Department of Roentgenology of Stanford University Medical School. A study of the stereoscopic x-rays of these fractures affords an excellent opportunity for the accurate classification of the sites of fracture and types of displacement occurring in this region.

In the United States it is customary to divide fractures of the proximal end of the humerus into fractures of the anatomical neck, epiphyseal separations, and fractures of the surgical neck. While this classification possesses the advantage of simplicity, it does not follow that such a grouping is either scientific or practical. In the Stanford series of cases there is not a single fracture of the anatomical neck of the humerus, and evidently modern authors have difficulty in obtaining satisfactory x-rays for textbook illustrations, for invariably the roentgenogram or x-ray tracing shows a high fracture in the region of the tubercles of the humerus. Stimson[11] is of the same mind, for he states that our knowledge of fractures of the anatomical neck of the humerus is limited to a few specimens and a few cases clinically observed in which the diagnosis remains doubtful, while in the published roentgenograms the fracture line runs in part, at least, through the tubercles.

On the basis of experimental studies conducted on human bones Kocher[6] divided fractures of the upper humerus into supratubercular, pertubercular, infratubercular, and subtubercular fractures (Fig. 1). Isolated fissure fractures of the articular head and fractures of the

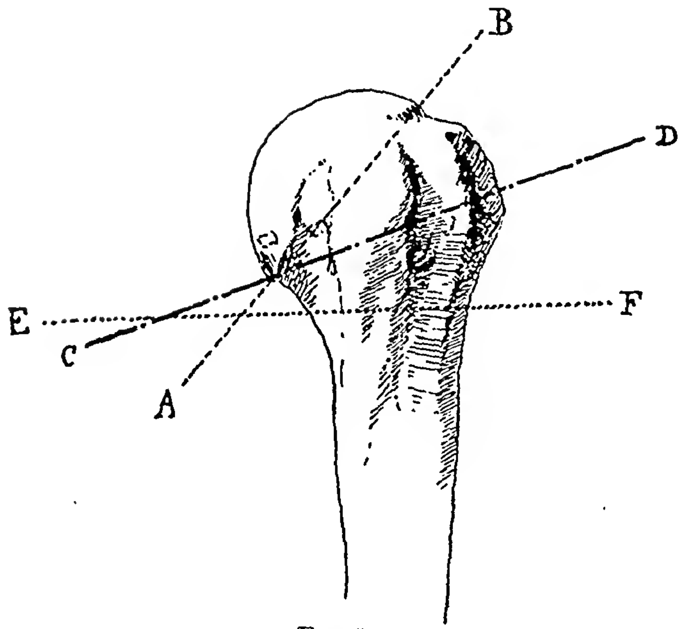

Fig. 1

(After Kocher). Fractures occurring above the line *AB* are the supratubercular fractures or fractures of the anatomical neck. Fractures occurring between the lines *AB* and *CD* are the pertubercular fractures. When the fracture line lies between the lines *CD* and *EF*, the fractures are called infratubercular, while those of the upper shaft below the line *EF* are the subtubercular type of fracture. *Reproduced from work by Theodor Kocher.*[6] (*See Bibliography.*)

anatomical neck were included in his supratubercular types, although Kocher was unable to produce true fractures of the anatomical neck in the cadaver, while the three cases he reports of fractures of the anatomical neck of the humerus rest upon clinical examination without anatomical or roentgenographic evidence of their true nature. The pertubercular fractures (Fig. 1) through the cancellous bone occur in a wedge-shaped zone bounded by the tubercles, the base being at the greater tuberosity laterally and the apex medially at the lesser tuberosity. Those fractures occurring at the lowest levels of the wedge are distinguished with difficulty from the highest of his infratubercular or subtubercular fractures. Unfortunately modern writers in the English language have discarded Kocher's logical classification.

Of the eighty-eight fractures studied stereoscopically, twenty-four were of the pertubercular type, fifty-five were infratubercular and subtubercular, five were epiphyseal separations, and four spiral or oblique fractures of the upper third of the humeral shaft with extension of the fracture to the region of the surgical neck.

Since the infratubercular and subtubercular types are most common, they are of major interest. Of these fifty-five fractures, forty-one were of the high variety or infratubercular type and are distinguished sometimes with difficulty, as mentioned before, from the lowest of the pertubercular fractures. All of these occurred in adults (See Figure 2 as to decades). Fourteen subtubercular or low surgical-neck fractures were found. Eleven of these occurred in children from four to ten years of age, while only three low surgical-neck fractures were found in adults. Twenty-five of this group of fifty-five were impacted, and in thirteen the greater tuberosity was split off as a separate fragment. Impaction and separation of the greater tuberosity occurred only in the infratubercular or high surgical-neck type.

The frequency of types of displacement of proximal and distal fragments is shown in Figure 3 and it is noteworthy that abduction, external rotation, and forward displacement (forward flexion of head and attached tuberosities) of the proximal fragment are most frequent, while internal rotation, medial and anterior displacement, and abduction are the most

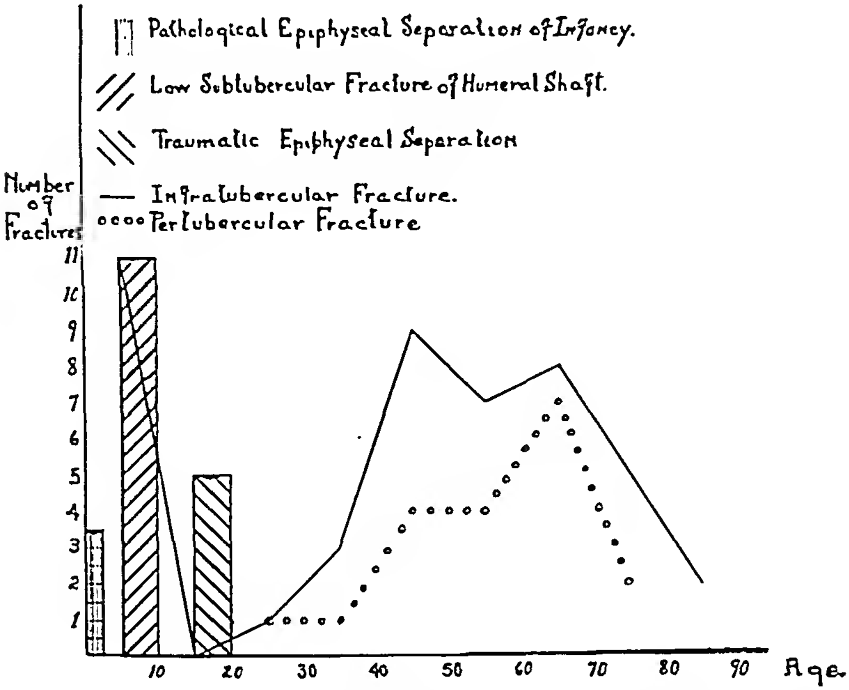

FIG. 2

Age frequency of fracture types in fractures of the proximal humerus. A striking characteristic finding is the occurrence of three different types of lesions during the first two decades of life, each lesion occurring in fairly constant and separate age groups.

constant findings in the lower fragment. Fractures of such a nature probably arise as an abduction injury. The position which the fragments assume when the arm drops, the one in which they are seen when the patient applies for treatment, and the one they tend to assume permanently if left untreated, is due to the adduction pull of the pectoral and the muscles of the torso, and to the lift of the deltoid, which together swing the loose lower fragment upward and medially. Internal rotation, adduction, and backward displacement of the proximal portion, and lateral posterior displacement, with adduction of the lower fragment, correspond to the adduction type of injuries of the German classification.

Shortening is universally present; it may amount to but a few millimeters in fractures in apposition, or with impaction, or it may reach as much as four centimeters, when overriding and actual displacement exist. The prevailing abduction of the upper fragment is due to the action of the supraspinatus and infraspinatus muscles attached to the greater tuberos-

	Infra-tubercular Fracture	*Per-tubercular Fracture*
UPPER FRAGMENT		
Impaction	25	20
Greater tuberosity fracture	13	12
External rotation	17	2
Internal rotation	14	12
Abduction	32	15
Adduction	7	1
Forward	20	15
Backward	5	0
LOWER FRAGMENT		
External rotation	0	0
Internal rotation	25	7
Anterior	17	11
Posterior	15	5
Medial	23	15
Lateral	11	1
Abduction	30	15
Adduction	17	8

FIG. 3

Frequency of types of displacement of the proximal and distal fragments in the infratubercular and pertubercular fractures of this series.

ity, while internal or external rotation depends more on the mechanism of the injury than upon the action of the subscapularis or teres minor in producing primary rotation of the upper fragment. Certainly it seems as though the subscapularis should be assigned more of a rôle in producing forward flexion of the head, since impaction and posterior or anterior displacement of the shaft occur with almost the same frequency. Such tilting forward or backward of the head by contact of the lower fragment, which is being pulled up by the biceps, triceps, and coracobrachialis, is the explanation frequently given for this displacement. In the light of the figures given above, such a mechanism is apparently incorrect, especially since tilting forward or backward is often present in unimpacted fractures. Again it should be remembered that the subscapularis has a relatively small area of attachment below the axis of rotation of the head, and, mechanically, forward tilting would occur easily through the action of this powerful muscle.

Medial displacement of the lower fragment is mainly due to pull of the muscles attached to the intertubercular groove,—the pectoralis major, latissimus dorsi, and teres major. This may be aided by the

lower external attachment of the deltoid, which, when a spasm of this muscle occurs, tends to elevate the lower fragment, while its proximal end is drawn in towards the axilla by the muscles of the intertubercular groove. Undoubtedly the short head of the biceps and the coracobrachialis muscles assist to some degree in this displacement, as well as in producing shortening, but it is difficult to evaluate the extent of their action.

Lateral displacement of the upper end of the distal fragment is an interesting type of deformity. No direct muscle action can explain it, but when we see that, of eleven fractures showing lateral displacement, all are accompanied by adduction of the arm, the explanation seems clear. The shaft of the humerus receives the attachment of the deltoid and coracobrachialis in its middle third. Adduction of the elbow to or beyond the side of the body would swing the upper end of this lower fragment out and laterally. This deformity is generally recognized as arising by adduction, either by forced adduction of the abducted arm, or hyperadduction of the adducted arm, as in falling forward with the arm held stiffly forward and across the body. Naturally such a deformity would disappear on abduction of the arm, and it is evident on fluoroscopic examination of unimpacted fractures in this region that abduction of the arm increases a medial displacement or converts a lateral displacement into a medial one, while occasionally a medial displacement becomes lateral on forced adduction. The persistence of the deformity is probably due to impaction which was present in eight of the eleven cases. Two of the remaining cases of unimpacted fracture presented low surgical-neck fracture with an oblique

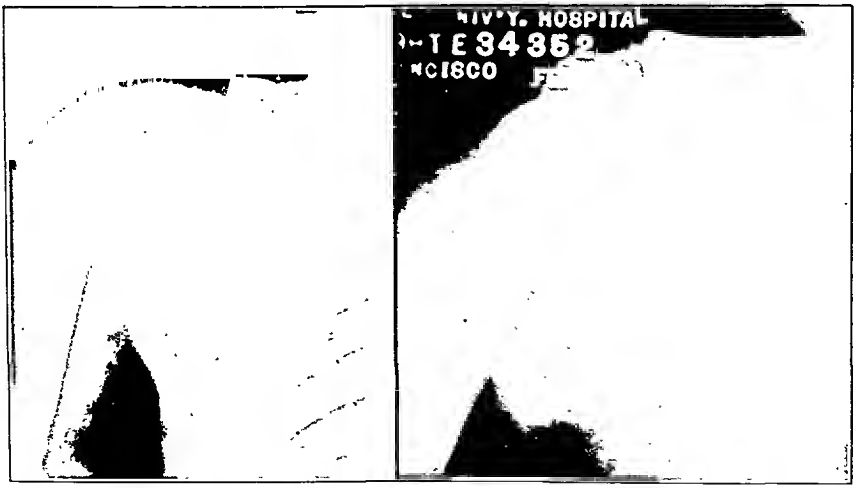

FIG. 4

Roentgenograms showing the characteristic type of fracture occurring in the first decade of life. The low position of the fracture line (subtubercular) corresponds to the region where the dense cortical bone of the shaft begins to be replaced by cancellous bone, having only a thin shell of cortex. The patient whose roentgenogram is at the left was four years of age. The patient whose roentgenogram is shown at the right was ten years of age, and sustained a typical buckling fracture of this region.

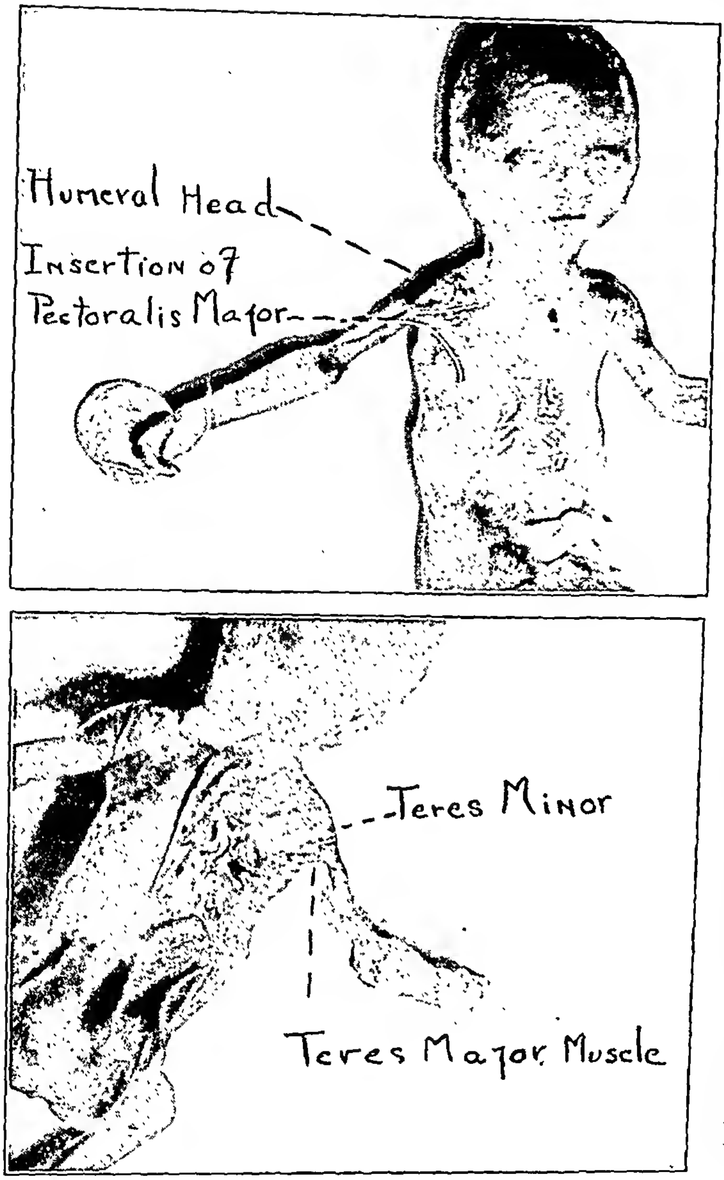

FIG. 5

Male foetus with dissection of shoulder girdle as described in the text. The low level of attachment of the pectoralis major, the teres major, and the teres minor muscles in relation to the total length of the humerus is shown.

fracture line running from above laterally down and medially.

Anterior or posterior displacement was almost equally frequent in the fifty-five lower fractures and probably is the result of the direction of the fracturing force, since a strong forward pull is exerted by the pectoralis major and an equally strong backward force by the teres major and latissimus dorsi. Internal rotation of the lower fragment is no doubt due to carrying the arm flexed at the elbow and across the body, either held by the opposite hand or in a sling, and the nature of the fracture line in these cases gives no evidence of torsion as a factor in its production.

Particular interest is attached to the group of subtubercular fractures occurring in young children, especially since, as will be later shown, the usual age for epiphyseal separation of the upper humeral epiphysis comes much later. These characteristic fractures occur in the age group of three to ten years, all within the first decade, and the striking thing is the low level of the fracture in comparison with the infratubercular fractures in adults. Seven of the eleven were buckling fractures with only five to ten degrees of abduction of the lower fragment (Fig. 4), while adduction occurred in one. Two were of the transverse type and two of the short oblique type, all with pronounced displacement of fragments. It is obvious from the roentgenograms that these fractures occur in the region of the upper shaft,

where the dense cortical bone begins to thin out and is replaced by cancellous bone (Fig. 4).

A less obvious, but equally striking fact, is disclosed by dissection of still-born infants. In a normal, still-born male foetus of six months, the muscles of the shoulder region were exposed by dissection. The deltoid muscle, the long head of the triceps, and the biceps muscle were carefully removed, and the axilla cleaned of fat and areolar tissue, taking away the axillary brachial plexus and the vessels. This left exposed the humero-scapular joint, with the attached teres minor, infraspinatus, supraspinatus, and subscapularis muscles with the teres major, latissimus dorsi, and pectoralis major attaching to the sides of the intertubercular groove. With a mechanic's divider the following measurements were taken: the length of the humerus from the head to the prominence of the lateral epicondyle of the elbow, the distance from the apex of the head to the epiphyseal line, and the lowest point of insertion of the teres minor and subscapularis muscles from the apex of the humeral head; and, finally, the highest and lowest points of insertion of the pectoralis major and the fused tendons of the latissimus dorsi and teres major were measured in the same manner (Fig. 5).

On an adult male cadaver of medium height and muscular development, corresponding measurements were taken. A most noticeable difference was the fact that in the adult cadaver the tough tendinous attachments of the pectoralis major, latissimus dorsi, and teres major extended up the intertubercular groove to the immediate neighborhood of the tuberosities of the humeral head, and that the teres minor and subscapularis both descended only a very short distance from the prominence of the greater and lesser tuberosities. After measuring the distance from the head to the prominence of the external condyle of the humerus on a dried, prepared, adult humerus, by mathematical formulae of proportions, the points of muscular attachments of the still-born and the adult muscles were marked off on a dried bone specimen.

Such a translation of measurements demonstrates strikingly the low attachment of both upper and lower insertions of the pectoralis major, latissimus dorsi, and teres major muscles in the still-born infant (Fig. 6). Anatomists[9] know that in the new-born the tendinous and ligamentary structures are less well developed than in the adolescent and adult. One must conclude that condensation of areolar tissue into tendon and tendonization of muscle tissue increase with increasing function. Experiments on dogs have shown that reformation of ligaments may occur after their complete removal as the result of condensation of fibrous tissue under continued mechanical stress.[2] So also it may be assumed that increasing use and activity gradually extend the tendinous attachments of these muscles higher upon the shaft toward the tuberosities and narrow the surgical neck proper as adult life is reached. How this occurs in the face of growth distalward from the proximal epiphyseal line remains to be explained.

Thus in young children, from the later part of infancy until the end of the first decade, there is a typical fracture of the surgical neck of the humerus, which is characterized by its low position in relation to adult fractures. This low position is probably related to the low insertion of the adductor group of muscles and to the low level of transition between cancellous and dense cortical bone that exists in the shaft of the growing humerus.

There were twenty-four fractures that from careful examination of the stereoscopic x-rays fell into the pertubercular class. Notably this type of fracture occurs only in adults beyond the age of closure of the epiphyses. In this small series the fracture was most frequent in the seventh decade of life, only two occurring before the fifth decade. These are the fractures that are commonly called fractures of the anatomical neck, both by surgeons and roentgenologists, and a number of this series were so diagnosed in the x-ray files. However, without exception, all were low pertubercular fractures and none approached the true position of the anatomical neck. As a group they are distinguished by impaction. Two of the twenty-four were unimpacted and two came for treatment over a month after the initial injury occurred, with malunion in a position limiting function and with stiff and painful shoulders. This speaks for initial impaction as well, and we can assume that twenty-two of the twenty-four were impacted at the time of injury. Kocher was able to produce this injury on human bones by compressive force on the head of the humerus against the glenoid; compression in the long axis, as follows a fall on the elbow, the head striking the acromion; or by a blow on the fixed head from the lateral and posterior aspect of the joint. He states that the broad cancellous fracture surface of the upper fragment lends itself to impaction by the strong cortical bone of the distal fragment. In the pertubercular type the fracture line is through the dense, tough attachment of the teres minor, infraspinatus, and supraspinatus muscles at the greater tuberosity and the subscapularis and capsular attachment at the level of the lesser tubercle. These investments should play a prominent rôle in limiting displacement. Fluoroscopic evidence is valuable here, for, in certain of these fractures which from stereoscopic examination appear impacted, on screen examination the impaction is found to be quite unstable; and motion at the fracture occurs easily with movements of the lower arm.

The greater tuberosity was fractured as a separate fragment in twelve of the twenty-four pertubercular injuries, while in the fifty-five of the subtubercular type, fracture of the greater tuberosity occurred only fourteen times. Frequently the fractured greater tuberosity was impacted into the upper humeral fragment, which is clinical evidence to substantiate Kocher's experimental production of pertubercular fractures by compressive direct violence.

In general the displacement of the fragments was much the same as in the infratubercular fractures (Fig. 3), the shortening being less and the amount of gross displacement limited by impaction. However,

changes in the longitudinal axis of the shaft and head were as frequent, though to a lesser degree. In pertubercular fractures the upper fragment rotated internally in twelve cases; seven of these were accompanied by fracture of the greater tuberosity and it seems as if, by the tearing loose of the greater tubercle, the subscapularis might be freed to some degree of the antagonistic external rotators, the teres minor, and the infraspinatus. In comparing the pertubercular type with the infratubercular injuries, one may mention that lateral displacement of the lower fragment occurred in only one case of the twenty-four, again pointing towards direct force and compression in the mechanism of the injury.

The pertubercular fractures of this series, then, deserve the separate classification originally accorded them by Kocher through their tendency towards impaction, their occurrence in the later decades of life, and the frequency with which the greater tuberosity is fractured separately, in addition to the compression mechanism of production proven by Kocher.

It was surprising, in this series, to find epiphyseal separation of the upper humeral epiphysis occurring entirely in the second decade of life. The five patients were fourteen, fifteen, nineteen, and two sixteen years of age. It is noticeable from the roentgenograms that the dense cortical bone of the shaft extends to the immediate neighborhood of the epiphysis, in contrast to the low fractures of the surgical neck in the first decade of life.

Parsons[5] has shown that, in young vertebrates, starting from the center of ossification of the shaft of the long bones, where cortical bone first appears, the cortical bone gradually extends and thickens to the articular ends, while the cone-shaped cartilaginous mass in the interior, which lies with its apex at the center of shaft ossification, and its base at the articular ends, gradually extends until conversion to osseous tissue is complete. Parsons also has demonstrated that the accessory centers of ossification arising in the immediate neighborhood of joints are traction epiphyses, such as the epiphyses for the lesser and greater trochanters of the femur and the greater and lesser tuberosities of the humeral head. From our dissection of still-born infants it was shown that the lower border of attachment of the teres minor was below the epiphyseal line, lower than that of the subscapularis; and the relatively larger size of the head and tubercular cartilaginous mass in the infant than in the adult was stressed. The centers of ossification of the traction epiphyses of the greater and lesser tuberosities fuse with the main upper humeral ossific center during the seventh year of life in the child, and from that time on the growth of the tubercles is coincident with this epiphysis. The rate of growth of the head must be proportionally less than that of the shaft, judging from the proportional sizes in infants and adults; and, with the retarded, yet progressive growth of the head and tubercles, the teres minor, infraspinatus, supraspinatus, and subscapularis muscles change their relative level of attachment and come to lie at a higher level and above, or in the immediate vicinity of, the epiphyseal line. At the same time the adductor group

—the pectoralis major, latissimus dorsi, and teres major muscles—move their higher borders of insertion near to the base of the tubercles and narrow the true surgical neck. These factors, then, with the gradual proximal progress of the dense cortical bone of the shaft, protect the upper shaft and place the strain in the neighborhood of the epiphyseal line, so that, in the second decade of life, epiphyseal separation results rather than fractures of the subtubercular or surgical-neck type. Epiphyseal separation or slip in infancy usually is secondary to underlying disease affecting the epiphyseal line or juxta-epiphyseal tissue,—such as congenital lues, scurvy, or rickets. Three such cases of epiphyseal disease, producing the pseudopalsy of Parrot, were found recorded in the files,—two occurring in infants of the first year of life, due to lues combined with scurvy from malnutrition and improper feeding, and the third due to scurvy alone.

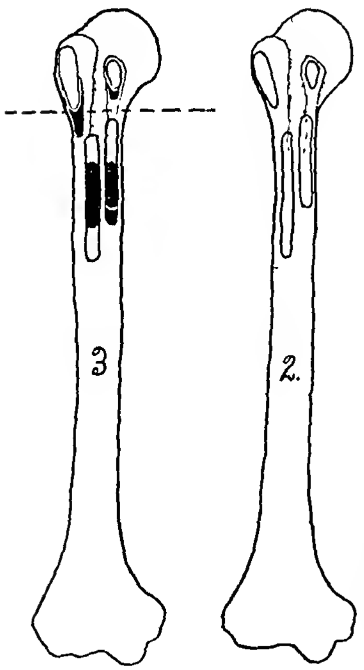

Fig. 6

The drawings are accurate scale drawings as regards length of the bone and the levels of muscular attachment.

1. Humerus of normal still-born foetus of six months. The proportionally large size of the humeral head, the level of the epiphyseal line, and the areas of attachments of the pectoralis major, latissimus dorsi and teres major, teres minor, and subscapularis muscles are shown.

2. Adult humerus with areas of attachment of the same muscles of the adult cadaver.

3. Adult humerus with areas of muscle attachment outlined as before. Superimposed upon these in black, are the areas of attachment of the infant's muscles, enlarged proportionately to the length of the adult bone. The dotted line represents the relative site of the epiphyseal line obtained in the same way. Such a transposition of measurements illustrates strikingly the low level of attachment of the tubercular muscles in the infant, the low level of the upper borders of the pectoralis major, latissimus dorsi, and teres major muscles in the infant, and the relatively low level of the so called surgical neck of the humerus in the growing child.

Four fractures of the upper third of the humeral shaft occurred. One was of transverse type at the lower level of the pectoral attachment and above the deltoid tuberosity; the typical proximal fragment adduction and distal fragment lateral displacement occurred, with shortening. The remaining three were spiral fractures of the upper third of the shaft, running into the region of the tubercles from as low as fourteen centimeters from the head of the bone.

As a means of study of muscle action of the humeroscapular joint, and for the purpose of testing the mechanics of reduction of fractures in this region, a so called phantom model was constructed. Mollier[7] made use of a mechanical model in order to analyze the action of muscles in relation to movements of the scapula. He prepared a cadaver by

dissection, removing the muscles of the arm and retaining the capsular tissue and short internal and external rotators attached to the humeral head, with the deltoid muscle. The muscles were removed from the trunk and cervical region and their tendinous attachments to the scapula were used for fixation of cords running to screw eyes at the points of insertion. They were led farther by a system of pulleys and rolls to the free ends of iron bars, the opposite ends of which were pivoted in a horizontal frame. By motion of the scapula and arm, traction or relaxation of the cords representing muscles resulted in lowering or raising the iron bars perpendicularly from their horizontal pivot. By measuring the rise or fall of the component system of iron bars from their primary position, Mollier was able to determine not only muscles producing movements in certain directions, but synergists and antagonists of the movement; and was able to observe the range of motion in the so called scapulothoracic articulation, the acromioclavicular and sternoclavicular joints. Otto Roith[10], several years later, constructed a similar model to determine the extent and range of movement of the femur and hip joint produced by action of different muscles of the thigh adductor group. Again the

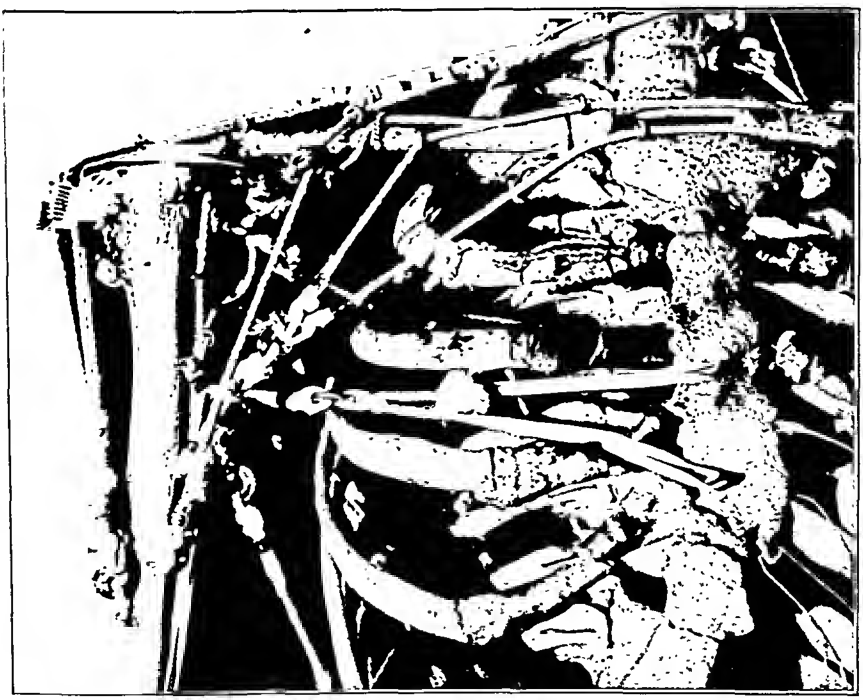

FIG. 7

Phantom model, anterior view. One can see the traction cords and rubber bands representing the pectoralis major, deltoid, latissimus dorsi, teres major, and long head of the biceps muscles. The head of the humerus is displaced in the glenoid in order to show more clearly the cord representing the subscapularis tendon and muscle. The heavy molded Bessemer steel wire represents the contour of the shoulder soft parts in order to simulate deltoid action more closely.

principle of measuring the rise and fall of weights in a perpendicular direction was used. In both these studies it was emphasized that only the directions and extent of movements produced by individual muscles were estimated, and those merely qualitatively, and it was realized that such a muscle phantom could not be used to derive exact quantitative data approaching the quantitative forces of muscles in the human body.

Qualitative data as to the actions of muscles about the glenohumeral joint could be utilized in relation to fractures of the upper end of the humerus. It occurred to us that in so doing the force of elastic traction could be substituted for measurement of excursion of weights of fixed value. Dr. W. Lyle Allred of the Department of Radiology, and formerly of the Department of Physics, Leland Stanford University, assured us that measurement of elastic traction could be used without loss of qualitative accuracy. Accordingly, a muscle phantom was constructed. in which rubber bands were substituted for the weights and pulleys of Mollier and Roith. These were connected to the humerus and shoulder girdle of a skeleton and run through screw eyes so as to follow as accurately as possible the true course of the muscles of the shoulder girdle and humerus. The deltoid muscle was represented by five cords, the pectoralis major by four, the latissimus dorsi by three cords, and the remaining muscles by one cord each. In adjusting the traction on the elastic bands, representing a muscle or portion of a muscle, the humerus was moved to the point producing the greatest relaxation of the band and the length of the corresponding cord was so adjusted and fixed that the elastic band was under minimum tension (just sufficient to maintain the length of band without flaccid drooping). Surprisingly enough, when such adjustments were completed and the arm allowed to assume its own position, it came to rest at the side of the skeletal thorax in about five degrees' abduction and in mid-rotation with the external condyle of the lower end of the humerus pointing directly laterally. After abduction, flexion, or extension of the humerus, it would return to this position by gravity, guided by the elastic traction adjusted in the manner described.

With the phantom model properly rigged, all muscles were represented that would be likely to produce displacement or hinder reduction of fractures. Grasping the completed model by the elbow or at the wrist, and abducting, adducting, rotating, flexing, or extending the arm, all motions were smoothly performed without jerking and in a surprisingly life-like manner. The humeral head, held to the glenoid by the tension of the elastic "muscle" strands, did not tend to subluxate or leave the gliding surface, except on marked internal or external rotation, positions in which the humeral head would partially subluxate and come to rest on the glenoid rim. It is of interest to note that, if the cord of the supraspinatus was released, the other muscle strands remaining as they were originally adjusted, movement of the shoulder joint was no longer smooth. The deltoid group pulled the humerus upwards and on slow abduction of the arm, the humerus first

rose to strike the under border of the acromion, then the humeral head rolled jerkily on the glenoid as further abduction took place.

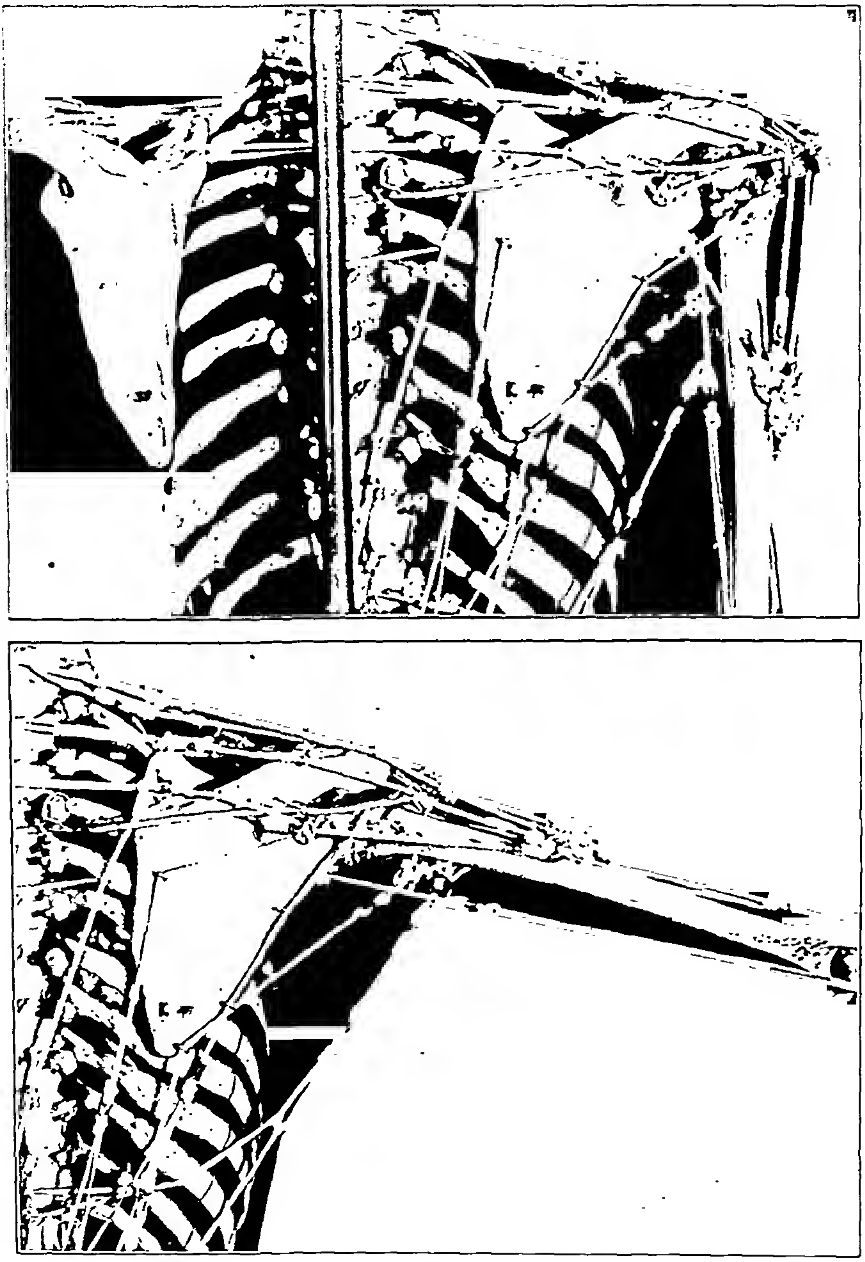

Fig. 8

Phantom model, posterior view. Cords and rubber bands representing the deltoid, supraspinatus, infraspinatus, teres major and minor, and latissimus dorsi muscles can easily be traced in the photographs, which show the model with humerus adducted and abducted. The scapula is fixed to the rib cage, parallel to the spinal column.

A delicate spring balance, accurate to twenty-five grams, was used to measure elastic tension on the muscle strands in different positions of the arm of the model. The humerus was firmly fixed in different positions and the tension was read separately in each position on every separate elastic band. The method consisted of releasing the elastic band, slipping the hook of the spring balance through the rubber, and recording the amount of force in grams necessary to restore the band to its original length at the screw-eye attachment.

It must be remembered that the phantom gives a mirror image, as it were, of what actually happens during muscular movement. Thus, for instance, the living arm is adducted by the pectoral, which contracts;

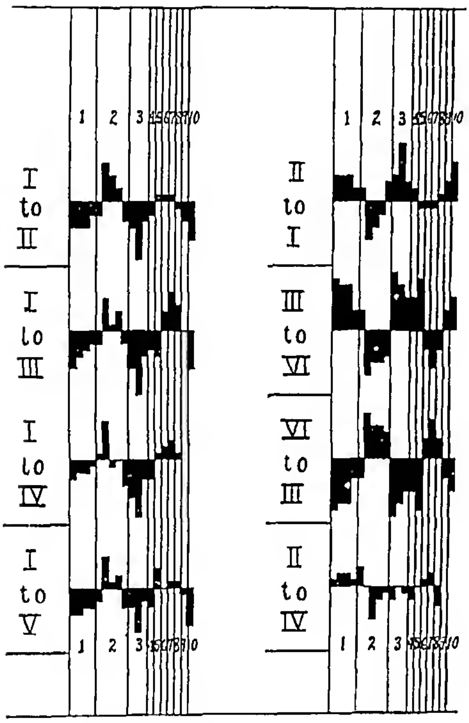

Fig. 9

Graphs representing muscle synergy and antagonism following different movements at the shoulder joint in the model.

The Roman numerals represent different positions of the arm:

I. Adduction of the humerus parallel with the spine with mid-rotation.

II. Abduction of the humerus to seventy degrees with mid-rotation of the arm, the forearm pointing horizontally forward.

III. Abduction of seventy degrees with complete external rotation, the forearm pointing perpendicularly upward.

IV. Abduction to seventy degrees with mid-rotation and thirty degrees forward to the frontal plane (Böhler's position).

V. Abduction to seventy degrees with complete internal rotation.

VI. Adduction to the perpendicular (parallel to the spine) with complete internal rotation.

Arabic numerals represent the different muscles:

1. Pectoralis major. *2.* Deltoid. *3.* Latissimus dorsi. *4.* Teres major. *5.* Subscapularis. *6.* Supraspinatus. *7.* Infraspinatus. *8.* Teres minor. *9.* Biceps. *10.* Triceps.

Muscles charted above the base line are synergists in the movements represented, while those below the base line are antagonists to the movement.

but the phantom arm is adducted not by the phantom pectoral, but by passively moving the humerus. The rubber pectoral does not contract; it becomes less taut and the measure of its contraction is the force necessary to stretch it to the tension which it originally had before the humerus was adducted. With this in mind, after checking the accuracy and constancy of the records for various positions of the arm, complete records were secured for six different positions.

These positions were numbered for future comparative data as:

I. Adduction at a perpendicular, with mid-rotation of the arm, the external epicondyle pointing straight laterally.

II. Abduction of the humerus to seventy degrees from the perpendicular with mid-rotation, the forearm pointing horizontally forward.

III. Abduction of seventy degrees with complete external rotation of the arm, the forearm pointing perpendicularly upward.

IV. Abduction to seventy degrees, mid-rotation, and thirty degrees forward in the frontal plane (Böhler's position).

V. Abduction to seventy degrees and complete internal rotation, the forearm pointing downwards in the long axis of the body.

VI. Adduction to the perpendicular (parallel with spinal column) and strong internal rotation.

Records, in units of twenty-five grams, of the readings of the spring balance in the six positions were charted on ruled chart paper. This chart served as the basis for further comparative studies. In diagrammatically representing the qualitative muscle action of the model, the tension in grams of a particular muscle in position *II* was compared with the tension on the same elastic band in position *I*. If in position *II* the tension were less than in position *I*, it would correspond to active contraction of the muscle in the living subject and the difference in grams in tension between position *II* and *I* was charted above the base line, representing active contraction of the same muscle. If the tension in position *II* were greater than the tension in position *I*, corresponding lengthening and relaxation of the same muscle would occur in the living subject, so that the difference in grams in tension was charted below the base line, and the muscle was shown to be an antagonist to the movement. Such comparisons of the different positions are seen in the chart (Fig. 9). By study of these graphs several interesting observations were made of action of muscles about the shoulder, some of them little known except to anatomists.

In raising the arm from position *I* to position *II* the active muscles are the deltoid, the subscapularis, the supraspinatus, and the infraspinatus muscles. The deltoid abduction function is universally known, but the fact that the most anterior and most posterior deltoid fibers act as antagonists to the acromial or lateral portion during the movement is not generally appreciated. In Figure 9 this antagonism is well shown. Duchenne[4] demonstrated that the posterior fibers arising from the scapular spine are able to abduct the arm to forty-five degrees, beyond which they act as antagonists to abduction. The anterior clavicular fibers serve to flex the arm forward, the posterior scapular fibers to extend the arm backward. This tripartite action of the muscle, which originates in a broad base and inserts in a relatively small point, makes for smoothness and stability of motion in the way that guy ropes steady and aid in raising a boom derrick. In the same way the apparent paradox of the subscapularis in assisting in abduction is explained by the fact that, beyond forty-five degrees' abduction, the subscapularis attachment lies above the center of rotation of the humeral head and the muscle is enabled to assist the deltoid in this movement. This is plainly shown in von Bardeleben's Handbook of Anatomy.[12] That the supraspinatus and infraspinatus are synergists to the deltoid in abduction is self-evident from their position of mechanical advantage. Although Duchenne is of the opinion that the supraspinatus

is able to accomplish elevation of the arm in abduction unaided by the deltoid, we feel that it does not play such a major rôle as a synergist unless developed in compensation by paresis of the deltoid. In the model the deltoid is represented by five cords, the supraspinatus by one. Von Bardeleben's data on comparative muscle weight shows the deltoid to be over five times the size of the supraspinatus muscle mass and, in addition, the supraspinatus possesses the direct mechanical advantage of having its long axis at right angles to the adducted humerus. As mentioned before in observations on movement of the model without tension on the supraspinatus elastic band, movements of abduction are jerkily performed with tendency for the humeral head to be elevated perpendicularly by the deltoid pull, so that it seems that the function of the supraspinatus initiates the gliding motion of the humeral head and maintains the humerus in firm apposition with the fulcrum of the glenoid, while the deltoid does heavy duty in the abduction movement. While the subscapularis is shown to assist in the movement of abduction beyond forty-five or fifty degrees, the teres minor maintains its adduction function and is an antagonist of the movement by virtue of its attachment to the extreme posterior and lower portion of the greater tuberosity, which descends to a lower level than the lesser anterior tuberosity. That the pectoralis major, latissimus dorsi, and teres major are antagonists to abduction is self-evident. The antagonistic action of biceps and triceps

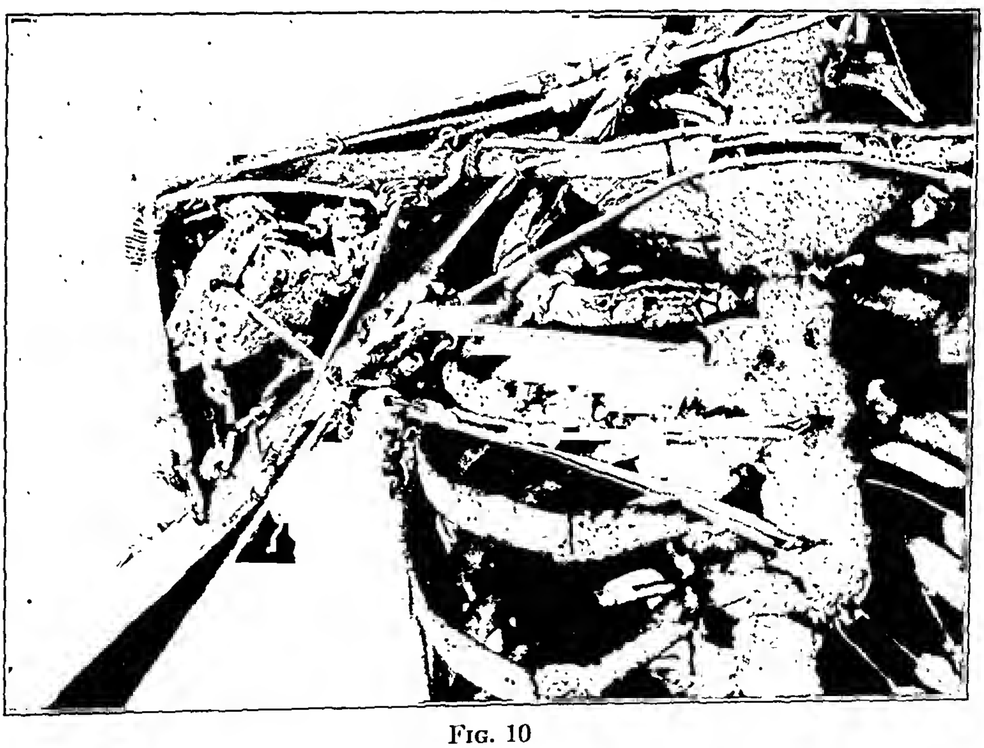

Fig. 10

Phantom model with typical fracture, and typical but exaggerated deformity produced by fracture in this region. It is apparent that only the cord representing the long head of the biceps spans the fracture and is in a position to act on both fragments.

depends on the fact that the humeral head points medially and cephalad with its axis set at 130 degrees from the long axis of the shaft, and the center of curvature of the head lies medially to the long axis of the shaft, so that during abduction of the humerus the length of the arm is correspondingly increased.

The graph comparing position *III* of abduction and external rotation with position *VI*, adduction and internal rotation, gives evidence of the internal rotating action of the pectoralis major as well as its more usual action of adduction and flexion. The same is true of the latissimus dorsi and teres major muscles for internal rotation and adduction, while the medial clavicular fibers of the deltoid assist in the same movement against the antagonism of the main muscle mass of the deltoid. The subscapularis gives evidence of its powerful, internal-rotating action and the biceps and triceps assist in adduction and internal rotation,—the biceps, since its course is across the humeral head within the joint capsule, firmly held in the intertubercular groove, so that even in marked external rotation of the arm the course of the biceps tendon lies anterior and forward to the center of rotation, and tension exerted on the tendon of the long head of the biceps assists in internal rotation. That this is undoubtedly true in the human body as well as on the muscle phantom is shown by the fact that in dissecting the unembalmed, still-born infant already mentioned,

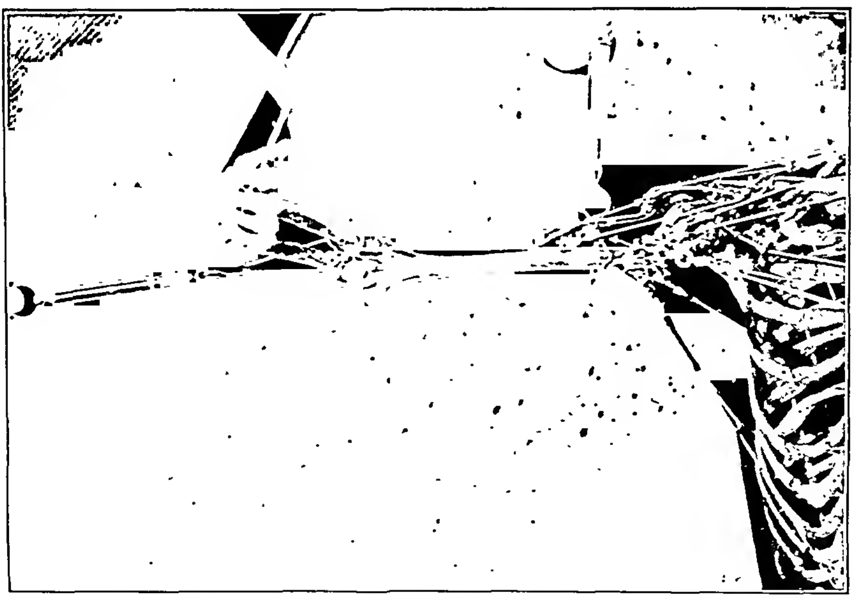

Fig. 11

Reduction of the fracture on the phantom model by abduction traction. In order to bring the fractured ends in contact, a second force acting in an upward direction is necessary, as shown by the two spring balances. In spite of both forces, angulation is persistent; and, if either force is released, redislocation of the fragments occurs. The marked tendency of the adductor muscles (pectoralis major, latissimus dorsi, and teres major muscles) to cause displacement can be seen in the photograph.

traction in the long axis of the humerus on the tendon of the long head of the biceps produced rapid internal rotation of the externally rotated humerus, both in abduction and adduction of the arm. The antagonism of the major portion of the deltoid, the supraspinatus, infraspinatus, and teres minor to adduction and internal rotation needs only to be mentioned.

In the movement from position *II* to position *IV*, the only motion is a horizontal one of the mid-rotated humerus, abducted to seventy degrees, to a position thirty degrees forward of the frontal plane. We see from the graph that the pectoralis major and the medial clavicular portion of the deltoid produce this movement, and the apparent paradox of the action of the supraspinatus and infraspinatus muscles in assisting this movement can only be explained by the humeral head gliding in a horizontal arc upon the glenoid surface and so bringing the attachments of these muscles (anterior and lateral on the greater tuberosity) nearer to their site of origin. The subscapularis muscle is shown to have no demonstrable action for this small range of movement. Again, the explanation from the muscle phantom lies in the fact that the subscapularis is attached so closely to the center of rotation that any tendency to shortening is overcome and balanced by tension exerted on its attachment as the humeral head glides posteriorly in the arc described. The teres minor muscle, on the other hand, attached most posteriorly and at a lower level, is put under tension and so is shown to be an antagonist. Loss

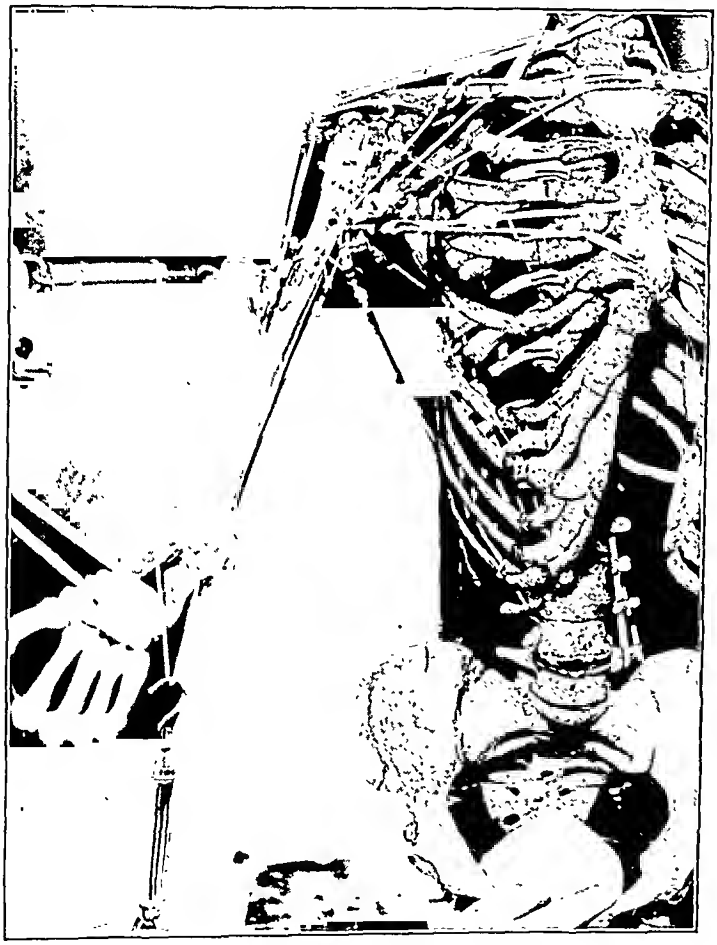

Fig. 12

Reduction of the fracture on the phantom model by downward traction. The manoeuver is easily carried out; the natural muscular forces, as represented by the traction cords, assist in the reduction; and after reduction the traction can be released without displacement of the fragments. The action of the long head of the biceps in spanning the fracture line and acting as a means of control over the upper fragment can be visualized from this photograph. In the living person traction straight down is used, since the tilt of the scapula and spinal column from the traction would represent almost this degree of abduction.

of cartilage in the skeleton amounts to about five-tenths of a centimeter and accounts for some incongruity. Motion pictures were taken of the muscle phantom model in action which demonstrate strikingly many of the foregoing facts mentioned in regard to the muscle synergy and antagonism.

On the muscle phantom, drill holes were made through the cortex in several places below the tuberosities and just above the attachments of the adductor muscles to the shaft. On sharply striking the bone in this region a transverse dentate subtubercular fracture was produced (Fig. 10). The action of the muscle strands of the model gave an exaggerated but typical displacement of the fractured fragments of the humerus. The proximal fragment was abducted, externally rotated, and pointed slightly forward. The distal fragment lay in the axilla medially; it was abducted, internally rotated, and shortened. The distal fragment could be made to ride anteriorly or posteriorly by pressure in the opposite direction on the elbow, the attachments of the adductor muscles (pectoralis major, latissimus dorsi and the teres major) acting as the fulcrum. By adduction of the humerus toward the mid-line of the body, lateral displacement and abduction of the tip of the lower fragment would be obtained. These positions, once assumed, remained stationary unless disturbed by external force.

Studies in reduction of the fracture were carried out in the following manner: A loop of cord was passed about the humerus at the level of the pectoralis major insertion and a second loop about the radius and ulna just distal to the elbow joint. A loop of cord at the wrist served to maintain the elbow flexed during manoeuvers.

Strong traction on the abducted humerus in the long axis of the distal humeral fragment overcame shortening; but the fractured end of the distal fragment maintained its medial displacement and refused to meet or make contact with the fractured surface of the upper fragment, since abduction of the humerus only served to exaggerate the medial displacement caused by the pull of the pectoralis major, latissimus dorsi, and teres major muscles, all adductor muscles and attached to the lower fragment. Simultaneous traction on the abducted humerus with a second force, at right angles to the first and in an upward direction, applied by means of the loop passed through the level of the pectoralis major insertion, would reduce the fragments. This is similar to the manoeuver of reduction by means of longitudinal traction of the abducted arm and simultaneous pressure up and out in the axilla on the distal fragment. However, both traction forces were necessary to maintain the reduction. If the perpendicular upward force were released, medial displacement immediately occurred (Fig. 11). If both forces were slightly decreased, beyond that necessary to maintain the normal axis and alignment of the fractured humerus, angulation of the fracture line occurred; and, if the forces were still further released, immediate recurrence of the original deformity took place.

In recent years Böhler[3] has advocated treatment of these fractures

after reduction by continuous traction and by splinting with the arm abducted to ninety degrees, in mid-rotation, and with the arm brought forward of the frontal plane of the body thirty to forty-five degrees. His reason for advocating this position is that it is the anatomical mid-position of movement of the arm in relation to the shoulder joint. On the model, reduction was attempted in Böhler's position by the action of a longitudinal traction on the abducted humerus, held forty degrees forward of the frontal plane, and a second force, acting from the upper end of the lower fragment and in an upward direction, at right angles to the first traction force. Results were obtained similar to those described in the preceding paragraph. Exact reduction could not be secured and, if either of the two traction forces were lessened, increasing deformity took place just as previously described, but with the additional deformity of angulation backward and anterior bowing at the fracture line, as well as the simultaneous medial bowing and lateral angulation described in the first manoeuver of reduction.

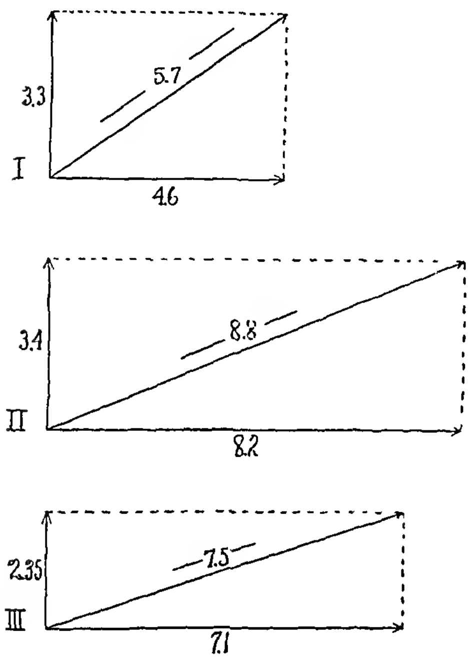

Fig. 13

Graphs representing parallelograms of force constructed from the forces necessary to reduce the fracture of the phantom model in three different positions.

I represents downward traction.

II represents the forces necessary to reduce the fracture by Böhler's position.

III represents traction with the arm in abduction.

The Arabic numerals represent pounds.

By downward traction in the long axis of the body, holding the arm slightly abducted (fifteen to twenty degrees), with simultaneous lateral right-angled traction on the upper end of the lower fragment, exact reduction of the fracture could be easily secured. The mid-rotated position of the humerus was obtained by pointing the flexed forearm straight forward. No matter what the position of the short upper humeral fragment, by this manoeuver of downward traction with lateral traction of the upper end of the lower fragment and mid-rotation of the arm, the fragments were pulled into alignment and almost exact apposition was secured (Fig. 12). Once this was secured, gentle release of both traction forces allowed the humerus to assume a hanging position parallel to the long axis of the body; and reduction was maintained by the "muscle" pull of the elastic bands alone, unaided by external force. Such a reduction could be secured by the manoeuver described in all positions of both fragments, although the upper fragment might be markedly abducted and externally rotated and the lower fragment be medial, lateral, anterior or posterior, adducted or

abducted. If the cord representing the long head of the biceps was released, all control over the upper fragment in manoeuvers designed to effect reduction and to bring the fragments into contact was lost, and reduction with angulation and bowing of one form or another was the best that could be obtained.

To determine the relative amount of force necessary to reduce the fracture in the three manoeuvers, traction with spring balances was applied in the manner previously described and readings were taken for both forces at the moment when shortening was overcome and contact of fracture surfaces secured. Repetition of the manoeuver at least six times in each position showed a uniformity of forces necessary for reduction in each position. For the strong traction necessary, the delicate gram-recording spring balance could not be used, so that readings were taken by means of obstetrical spring balances, which registered in pounds with quarter-pound subdivisions. After averaging the forces in each direction for the three manoeuvers, parallelograms of force were constructed for the three manoeuvers, and in the chart (Fig. 13) it is seen that the resultant in the case of the abducted position is seven and five-tenths pounds (Fig. 13, *III*); in Böhler's position (Fig. 13, *II*), eight and eight-tenths pounds were necessary; while with the arm hanging beside the body only five and seven-tenths pounds were necessary (Fig. 13, *I*). While the differences do not appear striking at first glance, thirty per cent. and fifty per cent. more total force is necessary in the abducted position and in Böhler's position for reduction of the fragments; moreover, with downward traction, after reduction has been secured, the traction can be released and reduction maintained; whereas, in the other two positions, release of traction results in recurrence of deformity.

After producing the fracture of the humerus on the muscle phantom, studies were carried out similar to those on the unfractured model. The tension readings on the strands in different positions of the humerus were charted in comparison with those readings obtained with the fracture "set" and in perfect position. While obtaining these readings, it was found that the balanced forces of muscle tension, as represented by the elastic traction, were necessary to maintain the fracture in its reduced position. For instance, if after setting the fracture the traction of the triceps was released, immediate dislocation of the fragments occurred. The same was true in regard to the biceps tension, and again particularly for the subscapularis and teres minor muscle strands, as well as for the deltoid muscle.

From a study of the graphs obtained with the fractured humerus, it is clear that a profound disturbance of the motor function of the skeletal-muscle apparatus occurs (Fig. 14). It is evident that muscles directly attached to the upper fragment (the subscapularis, supraspinatus, infraspinatus, and teres minor) retain their normal function and relation to each other as synergists and antagonists. However, the pectoralis major and the deltoid may become synergists instead of antagonists, as in the normal arm (movements *I to II*, *I to IV*, Fig. 14). The pectoralis

major and the latissimus dorsi with the teres major likewise may become synergists (movements *I to VI*, and *V to VI*, Fig. 14). In the normal arm the triceps and biceps passing from the glenoid to the elbow act as synergists in regard to the movements of the shoulder joint (Fig. 9). After a fracture they become antagonists (movements *I to II*, *I to III*, etc., Fig. 14). It is to be expected that a fracture would destroy the stability of the arm, but the quality of disturbance is only realized after a study of the graphic representation of the different movements. It is noticeable in movements of the fractured arm of the phantom model that a new joint is added and that the lower long fragment is comparable to a lever with its fulcrum at the deltoid insertion, the short end of the lever running from this point to the line of fracture. It is to be noticed that motions of abduction, adduction, flexion, and extension all occur about the deltoid attachment as the center of rotation, and the fractured end moves in a wide, none too stable arc. In placing the arm in Böhler's position (seventy degrees of abduction, thirty degrees forward of frontal plane) the distal end of the fracture rests on the axillary border of the scapula.

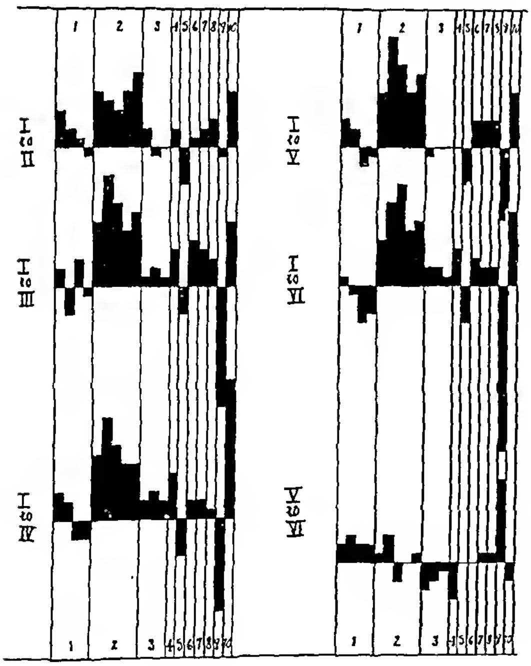

Fig. 14

Graphs showing disturbances of muscle balance that occur in the presence of a fracture.

I. The fracture reduced to use as comparison to the following movements.

II. Typical fracture as illustrated in Fig. 10.

It is evident that in movement *I* to *II* all the muscles except the subscapularis and long head of the biceps participate in producing the deformity. These two are the antagonists in preventing further deformity.

III. Lower fragment abducted to seventy-five degrees with mid-rotation.

IV. Böhler's position.

V. Lower fragment abducted to ninety degrees with complete external rotation.

VI. Lower fragment abducted to ninety degrees with complete internal rotation.

By such observations one finds that, in the presence of a fracture, muscles that normally act as synergists may become antagonists, while muscles normally antagonistic to each other may come to be synergists, and that the center and axis of rotation is changed to a new joint created by the fracture. One may take advantage of this knowledge in devising means of reduction and retention of such fractures.

TREATMENT

Bardenheuer's[1] clear exposition of the problems in fractures of this region deserves consideration today. From experiments on the cadaver

he became convinced that, with few exceptions, deformity could be reduced and reduction maintained by traction on the arm parallel to the body. His convictions were strengthened by observations made on a few cases that came to operation and by the results of his clinical experience with the traction method. He established the fundamental fact that traction on the lower fragment in fractures of the upper end of the humerus is transmitted to the upper fragment through the untorn periosteum and the tendon of the long head of the biceps muscle, and that such traction not only tends to draw the head fragment into line with the shaft, but that traction parallel to the body most advantageously overcomes displacement of the lower fragment produced by the adductor muscles, and draws the greater tuberosity, the shaft of the humerus, and the external condyle into a straight line.

In more recent years we find that the abduction form of treatment has almost completely replaced other methods and that the early fundamental work of Bardenheuer has been overlooked.

The abduction treatment in the form of the aeroplane splint, with or without traction, and the recumbent traction methods, have come into general use for two reasons. It has been accepted in these fractures that one has no control over the head of the bone, and that one should dress the lower fragment in line with the upper fragment. However, the remaining unbroken periosteum between the two fragments, and particularly the tendon of the long head of the biceps, gives us a means of control of the upper fragment. In addition, the lower fragment that we believed under our control becomes unmanageable in abduction, through the tension of the adductor muscles, and no matter how we use traction on the abducted arm we cannot maintain the fragments in apposition without a second force at right angles to the axis of the bone at the site of fracture. Clinical experience bears this out. In regard to Böhler's position, while it may be the so called mid-position in the normal and intact limb, when a fracture occurs we have added, as it were, a new joint; and new factors are added through the pull of muscles above and below this interruption in continuity.

The fact is often lost sight of that the tip of the distal fragment, after a fracture, no longer pivots about its former center of rotation in the joint cavity when it is moved, but describes a complicated curve with a course determined by the absence or presence of impaction, by various other restraints, by more or less taut ligaments and periosteal investitures, and by the varying pull of muscles, which after a fracture are suffused with blood, contracted, and in permanent spasm. This fact, that the tip of the distal fragment in unimpacted fractures never pivots about a *point* lying in the fracture line itself, but always slides along a curved *line* which lies outside the fracture line, would make one doubt the validity of a dictum announced recently by Böhler, but before him by many others, as a basic principle,—*viz.*, that the peripheral fragment must always be brought into that position to which the proximal one points.

This doctrine holds good for fractures with fragments firmly enough entangled for the distal one to have no tendency to slip, for in such fractures the distal fragment does pivot about a point and may readily be brought into line with the central one. In unimpacted fractures, however, in which heavy contracted muscle masses pull the distal fragment centripetally, efforts to bring the distal piece into line with the central one may, and usually do, cause the distal tip to wander centrally and alignment is secured only at the cost of an increase of shortening which is difficult to overcome. Examples of such fractures are fractures of the humeral and femoral necks.

It is partly true that in these fractures the short central fragment, freed largely of the pull of attached muscles, seeks a new position between flexion, extension, abduction, and adduction, described by Zuppinger and Christen[13] as the neutral position of major relaxation. This is only partly true, for a few muscles (for example, the supraspinatus) still cling to the short central fragment and act upon it unopposed and partly determine its position. It is no longer true, however, that this same position is the position of neutrality and major relaxation for the distal fragment. The distal portion of the bone only tends to assume this position as long as it is unbroken and pivots about its normal center of rotation in the joint cavity. After fracture the normal neutral position becomes one into which the distal fragment can be forced only by the expenditure of much effort. If this is so (and we think that our studies on the phantom have shown that it is, for the humeral neck at least), then we think that it is better to forego attempts at securing an alignment, obtainable only at the cost of so great a central displacement of the tip of the distal fragment, and to attempt first to entangle the fracture ends securely enough to prevent the distal end from wandering. Once this is done, the investing muscle masses will have a tendency to pull two pieces of a more or less square break into line by themselves.

The second reason given for the use of abduction is that, after prolonged fixation in adduction, it is difficult or impossible subsequently to regain the movement of full abduction. This is true of prolonged immobilization in adduction, but if early and progressive active motion is carried out, especially after the manner advised by Donald Gordon[5], the mobility of the shoulder joint is maintained and abduction and external rotation are early in their return.

The experiments upon the phantom model have given us a logical explanation for the success of a method of treatment of fractures of the upper end of the humerus that has been used by one of us for years. Its simplicity, the fact that patients are ambulatory, and that with proper after-care full function is restored, recommend it over the abduction methods now in vogue. The success of the method depends upon the integrity of the long biceps tendon. As demonstrated on the phantom model, if this tendon strand is missing, all control over the upper fragment is lost. Clinically the mechanism of the reduction manoeuver would not

be available in those fractures accompanied by avulsion of the tendon, or possibly when the tendon becomes torn from the intertubercular groove, in which it is held by tough fibrous bands. It is noticeable in those patients having fractures in this region that the mobility of the elbow is unimpaired, except that attempts at complete elbow extension produce pain in the fracture region. Obviously complete extension causes tension on the long biceps tendon bridging the fragments, and this manoeuver can be used to test the integrity of the tendon prior to attempted reduction. Bardenheuer felt that the untorn periosteum was of prime importance in control of the upper fragment, and gave the biceps tendon only secondary consideration. In the light of work with the phantom model, where the tendon of the biceps alone bridged the two fragments, it cannot be assigned a minor rôle, and becomes of major importance in effecting reduction.

When this tendon is torn, open reduction would seem the method of choice. A single loop of silver wire suffices for fixation. When the biceps tendon is intact closed reduction is indicated.

The reduction manoeuver is best carried out under local anaesthesia. Twenty to thirty cubic centimeters of one per cent. novocain with adrenalin are injected into the line of fracture. With the patient sitting upright, supporting the injured arm across the body with the opposite hand, a folded face towel is placed over the forearm just below the elbow. A four-inch or six-inch heavy muslin bandage is looped over the towel and tied in a sling, so that its lower end hangs from eight to twelve inches from the floor. An assistant grasps the wrist of the injured arm and, bringing the forearm at right angles to the body in the sagittal plane, maintains right-angled flexion of the elbow. The surgeon then

Fig. 15

Method of reduction under local anaesthesia. The patient sits upright on chair or stool. A folded towel is placed over the flexed forearm at the elbow. Traction is secured on the arm by stepping in the muslin sling and gradually bearing more and more of one's body weight on the sling. Both hands of the surgeon are left free to manipulate the central end of the distal fragment. An assistant holds the patient's forearm flexed to ninety degrees at the elbow and at the same time aids in maintaining the patient's upright position against the traction which is being exerted on the flexed forearm. If the surgeon places the toe of his foot beneath the rung of the stool and dorsiflexes the foot while gradually bearing more weight on the sling, the procedure is a steady, well controlled, progressively increasing traction.

places one foot in the sling, grasps the upper arm with both hands below the line of fracture, and slowly and steadily increases the amount of pressure on this foot (Fig. 15). It is often of advantage to have the patient on a stool, in order to use the lower rung as a fulcrum for the toe of the foot applying the traction force. This not only steadies the foot, but increases the amount of force one can use. The two hands grasping the arm below the fracture are used to force the upper end of the distal fragment laterally, anteriorly, or posteriorly, as required by the displacement. In those fractures with marked abduction of the upper fragment, it is well to have an assistant bear down upon the upper fragment while traction is being applied. Reduction is usually secured and maintained by this manoeuver. Reduction is manifested by restoration of the normal contour, alignment, and axis of the arm, but when in doubt fluoroscopic examination may be used to check the position. In apparently impacted pertubercular fractures, ten to thirty degrees of abduction or adduction deformity may exist, and by this method such deformity of the axis of the bone may be corrected without displacing contact of the fragments. It is this type of fracture that is often treated by simple immobilization for fear of breaking up impaction and converting the fracture into one with displacement, with which it is difficult to deal. If possible, stereoscopic x-rays that can be viewed while wet may be taken. Fluoroscopic control during reduction often aids in anatomical restoration of bone contour. An anteroposterior view is not *sufficient; a lateral view will occasionally* reveal much unsuspected anterior displacement.

The dressing is as simple as the method of reduction. A small pad is placed in the axilla and along the arm. The forearm is held flexed by a sling, while the arm is loosely bound to the body; the elbow is left free to allow the weight of the arm to act as a traction force (Fig. 16).

The advantages of this method over abduction in an aeroplane splint are obvious. The theoretical difficulties of reduction and maintenance of position in abduction have already been recounted. If the aeroplane splint is bad in theory, it is worse in practice. That it is uncomfortable, no one will deny; one might put up with the discomfort did it do what it is intended to, but it does not. It is an exceedingly difficult splint to apply; its countless variations

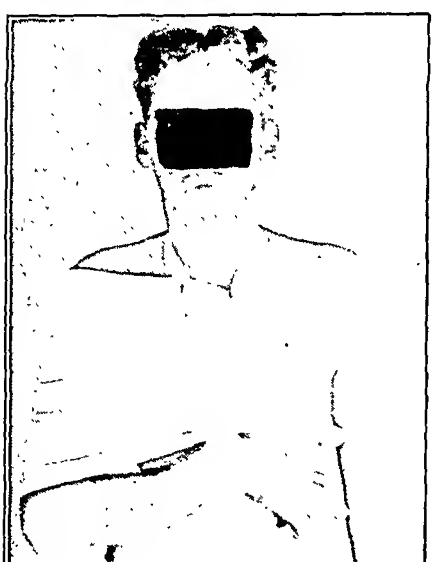

Fig. 16

The dressing for ambulatory care after reduction by adduction traction and manipulation. A small pad is placed in the powdered axilla, the flexed forearm is held from the wrist by a sling about the neck, and a muslin sling confines the arm to the body to prevent abduction of the arm. The elbow lies free; the weight of the arm, unsupported except at the wrist, acts as an ambulatory traction force.

vouch for that. It is so difficult to keep in place that most orthopaedic surgeons have forsaken it and replaced it by a plaster-of-Paris bandage which includes both shoulders, the chest, and the whole of the broken arm. The weight of this cumbersome plaster, plus the weight of the broken arm, hangs from the good shoulder and bears against the opposite part of the chest, while the elbow of the broken arm is unsupported. Thus, all traction effect is lost. If plaster is not used, the aeroplane splint proper, as usually applied, does exactly the opposite of what is intended. It slips down from the axilla of the broken arm and the distal fragment which is tied to its horizontal portion slips down with it, thus producing the deformity it purposes to avoid. Most surgeons who take the trouble to examine and control their treatment daily are aware of this difficulty. The voices of advocates of the splint are gradually getting weaker and weaker and its most consistent users are general practitioners, who are still floating in the backwash of the wave of enthusiasm that carried it into popularity twenty years ago.

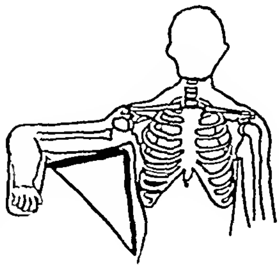

FIG. 17

Sketch showing the frequent deformity that occurs when the aeroplane splint is used. The splint slips down from the axilla, carrying the distal fragment and the arm with it. Deformity even greater than that illustrated is of frequent occurrence.

The success of restoration of function rests on intelligent use of exercise. Gentle massage may be used from the beginning by removing the body bandage. A small range of passive motion may be used in the first week, carefully controlled by the surgeon himself. At the end of the second week active motion is instituted. The bandages are removed; the patient stands with the sound arm resting on chair or desk and, bending forward, allows the injured arm to hang unsupported. The arm may be safely swung forward and backward and in small circles. The range of motion is increased so that by the end of the third week from seventy-five to ninety degrees of abduction are possible by tilting the trunk in this stooping-standing position. Such ranges of motion may be undertaken early, since at no time do the muscles bear the full weight of the limb as in the upright position. At the end of the fourth week more strenuous active motion, to the point of pain, is advised, and in eight

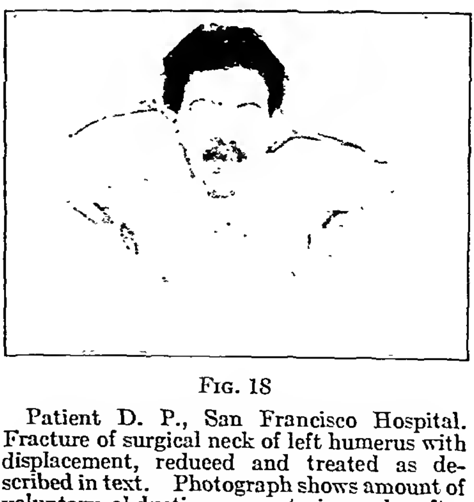

FIG. 18

Patient D. P., San Francisco Hospital. Fracture of surgical neck of left humerus with displacement, reduced and treated as described in text. Photograph shows amount of voluntary abduction present six weeks after reduction.

weeks' time the patient has a painless, movable, and useful shoulder, with almost normal range of motion that increases as the arm is used in the daily tasks of the individual. An instance of reduction by this method is shown in the accompanying illustration (Fig. 18).

SUMMARY

1. The frequency and types of deformity common in fractures of the proximal end of the humerus are tabulated according to Kocher's classification, which should be revived in the interest of accuracy and clinical usefulness.

2. Anatomical factors leading to the production of the low subtubercular fractures peculiar to the first decade of life are discussed. These fractures deserve recognition as a separate type peculiar to this age group.

3. The fact that epiphyseal separation of the proximal humeral epiphysis occurs during the second decade in life is emphasized and factors giving rise to it are discussed.

4. By the use of a phantom model the qualitative action of the muscles of the shoulder joint can be studied and expressed in graphic form.

5. The phantom model is of service in a study of methods of fracture reduction and enables one to determine graphically and by the use of motion pictures anatomical factors that are of value in clinical application.

6. The assumption that in fractures of the upper end of the humerus one must dress the long fragment in line with the short fragment, over which one has no control, is erroneous. One has control of the short fragment by virtue of the long head of the biceps bridging the fragments, and the remaining untorn periosteum.

7. It is emphasized that, when the arm is abducted, the pull of the adductor muscles makes approximation difficult to obtain and still more difficult to preserve. Clinical experience bears this out.

8. Accurate approximation can be obtained and maintained by downward traction, a fact demonstrated on the phantom model and by clinical experience. The integrity of the long head of the biceps tendon is necessary for the use of this method.

9. A simple method of reduction under local anaesthesia for fractures of the upper end of the humerus is described. This method makes possible the use of ambulatory treatment without splinting.

10. By adequate after-care function is restored almost as soon as bony union is complete; and a painless, useful joint is regained.

NOTE: Recently, on our Service, three cases of fracture of the proximal humerus have been treated which could not be reduced by the method described. Two were pertubercular fractures, the upper fragment markedly abducted so that the fracture surface looked up and out, and the lower fragment was displaced medially into the axilla and drawn up. The third was a case of epiphyseal separation with a splintering fracture of the posterior portion of the cortex of the humerus, a long fragment of the cortex remaining attached to the epiphysis. On examination all three gave evidence of rupture of the long head of

the biceps tendon, as described in the foregoing article; and complete extension of the forearm was possible, without producing pain or muscle spasm of the biceps brachii. Two of these cases were operated upon and the biceps tendon found to be ruptured. With the third patient, although skeletal traction with abduction was resorted to in an effort to reduce the fracture, malunion occurred with the persistence of much of the original deformity.

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THE TREATMENT OF FRACTURES AND FRACTURE DISLOCATIONS OF THE SPINE

BY R. WATSON JONES, B.SC., M.CH.ORTH., F.R.C.S., LIVERPOOL, ENGLAND

For many years before his death, Sir Robert Jones advocated the use of a hyperextended spinal frame in the treatment of fractures of the spine, recognizing that displacements produced by hyperflexion could only be corrected by hyperextension. Several isolated cases of manipulative reduction by traction and direct pressure over the kyphos were later reported [1,2,3]. In 1929 Davis [4] advocated hyperextension and traction by overhead-pulley suspension by the feet of the prone patient who was fully anaesthetized. A forcible direct thrust was then applied to the injured area, and a plaster bed made in which the patient remained recumbent for many months.

In 1930 the author [5,6] reported a method which was believed to be safe. The conscious patient was laid prone between two tables so that his spine gently sagged to the normal limit of hyperextension. This simple measure had been found adequate to reduce even gross displacements. No manipulation, traction, nor direct pressure was employed; the manoeuver was devoid of force. Anaesthesia was not necessary. As the patient lay between the tables a plaster jacket was applied, extending from the groins to the neck. Since reduction was so gently effected that anaesthesia was unnecessary, no shock resulted, and the plaster could be applied within a few hours of injury. The use of a jacket instead of a spinal frame or plaster bed facilitated nursing; the patient could sit up and be turned regularly into any convenient position, so that pulmonary congestion was avoided. Within a few days he was fully dressed, leading a more or less normal life and practising exercises for the erector spinae muscles. Functional disorders were minimized.

In the four years which have since elapsed, the author has found no reason to depart from this practice.[7,8,9,10,11] Records of eighty cases, which include fifty-seven personal cases and twenty-three treated by other surgeons, have been collected and reviewed. The results have been highly satisfactory and have shown that the principles underlying the method may remain unchanged.

THE PRINCIPLES OF TREATMENT

Reduction by Hyperextension

The fracture is produced by forcible hyperflexion. Once the compact layer of the vertebral body is fractured, the delicate framework of cancellous bone readily collapses and the vertebra becomes wedge-shaped. If the spine is hyperextended, the cancellous bone opens up with equal facility and the fracture automatically becomes reduced. There is no indication for traction, however severe the displacement may be, and

direct pressure is most certainly to be avoided. It is necessary that the normal limit of hyperextension shall be reached, so that the patient's trunk must be allowed to sag between the two points of support as he lies prone. The simplest method is to use two tables one higher than the

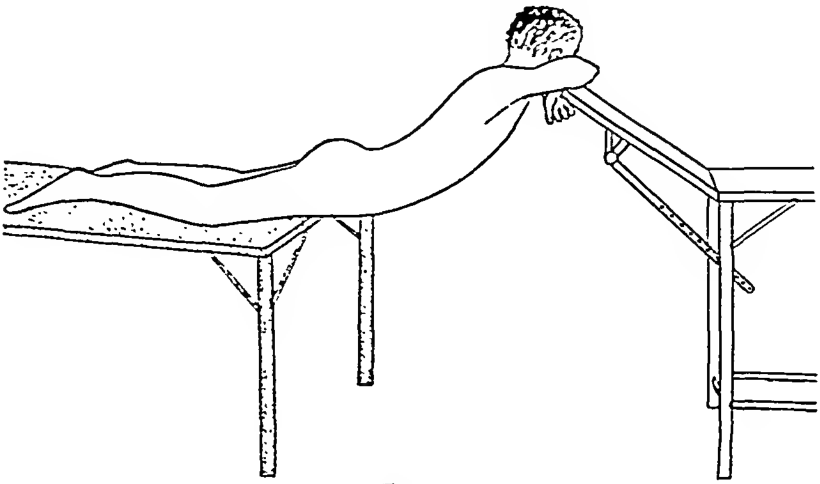


FIG. 1

The method of reduction in its simplest form. (By courtesy of the *British Medical Journal*.)

other, the lower table supporting the lower limbs as high as the groins, and the higher table supporting the head and the upper limbs (Fig. 1). Slight modifications are introduced for the three regions of the spine.

Anaesthesia

No anaesthetic should be used. Although discomfort may arise, particularly in the arms where weight is borne and in the abdominal wall where there is a "stretched feeling", no severe pain is complained of, provided that the operator completes the plaster rapidly. There is no necessity for any pause; by the time the plaster is dry, the fracture will be reduced, and the whole procedure should be completed in ten to fifteen minutes (Figs. 2-A and 2-B). The patient rarely complains of pain in the back, so that local anaesthesia is a waste of time, even if it be accepted that it is possible to anaesthetize an impacted crush fracture.

Not only is a general anaesthetic unnecessary; it is undesirable. The position can be maintained more easily in the conscious than in the unconscious patient. The two early complications of spinal fracture—shock and pulmonary congestion or pneumonia—are both aggravated by anaesthesia. In none of the eighty cases under review did chest complications develop. Moreover, in fracture dislocations of the spine the possiblity of effecting overreduction with further cord injury is conceivable if the patient is anaesthetized and the muscles are fully relaxed. Such a complication has not been observed in any of the twenty-one cases of fracture dislocation which have been reduced

without anaesthesia. The author never hesitates to apply the same method whether or not, in addition to the vertebral body injury, there be a fractured pedicle, fractured lamina, or dislocated interarticular joint. Morphine should not be administered too freely, for it may produce abdominal distension which, together with the rigid plaster over the abdominal wall, predisposes to paralytic ileus. Paralytic ileus is not due to the hyperextension; it may be observed after hip operations where a plaster spica is applied and large doses of morphine given. A quarter-grain injection immediately before reduction should be regarded as the maximum dose.

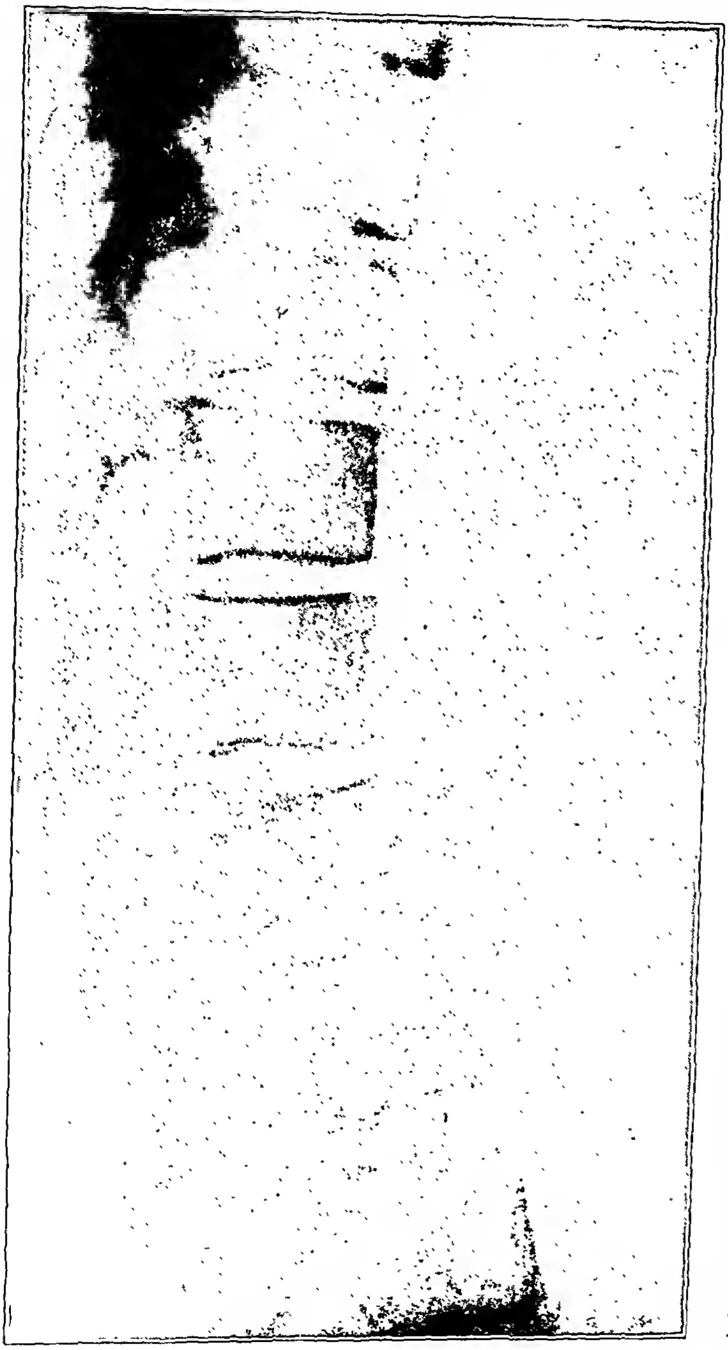


Fig. 2-A

Simple wedge fracture of the twelfth dorsal vertebra. Before reduction.

Immobilization

Recurrence of deformity is fully controlled by a well-fitting plaster jacket applied over a double layer of stockinet or a woolen bathing costume. Bulky padding must be avoided. Provided that the jacket extends from the symphysis pubis to the clavicles, there is no necessity for recumbency (Fig. 3). An error which is sometimes seen and which allows redisplacement even in lumbar fractures is that of extending the plaster no higher than the nipple line. A plaster spica is not necessary if the jacket is well molded to the pelvis, but in high dorsal fractures the plaster should include the neck

as high as the jaw. In none of the personal cases which have been reviewed has displacement recurred while the jacket was in position, although in every uncomplicated case the patient was allowed to walk within a few days.

Duration of Immobilization

Fractures of the vertebral bodies are apparently slow in consolidating (Figs. 10-A and 10-B). In one case a comminuted lumbar fracture was reduced and, despite early ambulation, there was no recurrence of deformity four months later when the jacket was removed. A posterior spinal support was then fitted and worn continuously, but the vertebral body collapsed again during the fifth month and angulation of the spine occurred. For this reason posterior spinal supports are no longer used at any stage of treatment; the complete jacket is retained until there is roentgenographic evidence of consolidation. The average duration of immobilization is three months in slight wedge compressions, four months when the compression is more severe, and six months when the vertebral body is comminuted.

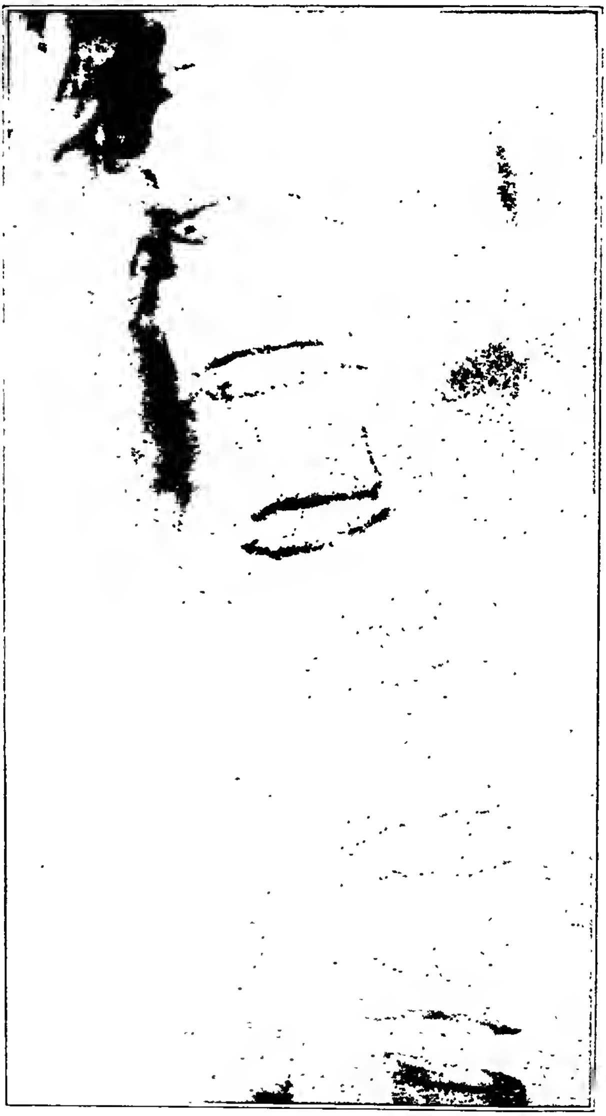


Fig. 2-B
Six months after reduction.

After-Treatment

Until the plaster is thoroughly dry, the patient lies with pillows beneath the concavity

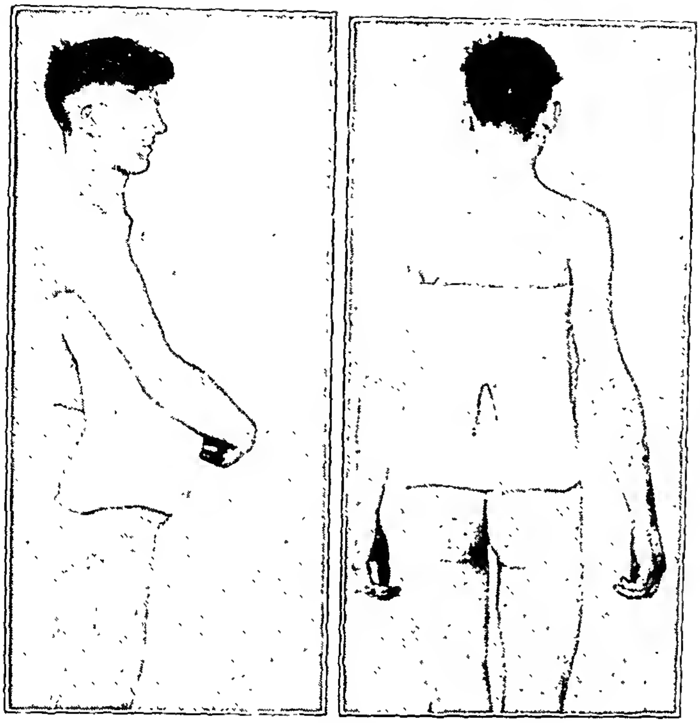


Fig. 3

The completed plaster jacket. (The felt beneath the window should not have been removed.)

of the arched spine. From then onward the position is changed every three hours during the day in order to avoid hypostasis. The patient is allowed to sit up at once, and within a week he commences walking. Considerable emphasis is laid on the early resumption of normal dress and normal habits in order to prevent the onset of functional disorders. After a week, spinal exercises are taught which the patient practises regularly. While lying on the face with the arms by the side, the head and shoulders are slowly raised from the bed and lowered again (Fig. 4). Each hip is slowly hyperextended with the knee straight, and, as the patient becomes more expert, both hips are simultaneously hyperextended. These exercises are far more effective in maintaining the tone of the spinal and abdominal musculature than any direct faradic stimulation or massage, even if such treatment were possible.

After the fracture is consolidated, the jacket is removed and flexion exercises for the spine are commenced. Occasionally patients are unable to stretch the intermuscular adhesions fully, and in such cases the spine is manipulated under anaesthesia.

Complications

The only complication which has been observed in cases without paraplegia is the development of a pressure sore over the spinous processes at the dorsolumbar junction, and this has been most difficult to avoid. Not only is this the level of maximum forward curvature of the plaster, but, since it is the usual site of fracture, it is also the level at which there is a continual tendency to the development of kyphosis, prevented by contact with the plaster. Additional padding beneath the plaster is inadequate, and, if a window is cut, the unsupported tissues become oedematous and pressure sores develop at the margins of the window. It is necessary to combine the two methods by applying a piece of three-quarter inch adhesive felt (six inches by four inches) beneath the plaster, and cutting

a smaller window in the plaster (four inches by two inches) centered over the felt which is not cut.

REDUCTION OF LUMBAR FRACTURES

The simple two-table method, which requires no special apparatus and has the advantage of being applicable in any country cottage, is quite adequate in reducing the common fractures of the lumbar spine and the lumbosacral and dorsolumbar junctions. It is an advantage, however, to use for the higher of the two tables, an operating table which may be pumped up to the desired level. In this way the hyperextension may be secured gradually. Moreover a shoulder sling carrying weight to a pulley on the wall behind the patient reduces the strain of body weight, which is otherwise experienced in the upper limbs. A roller towel beneath the patient's feet prevents him from sliding down the lower table and adds to his comfort (Fig. 5).

A complete ventral hammock suggests itself as a more comfortable

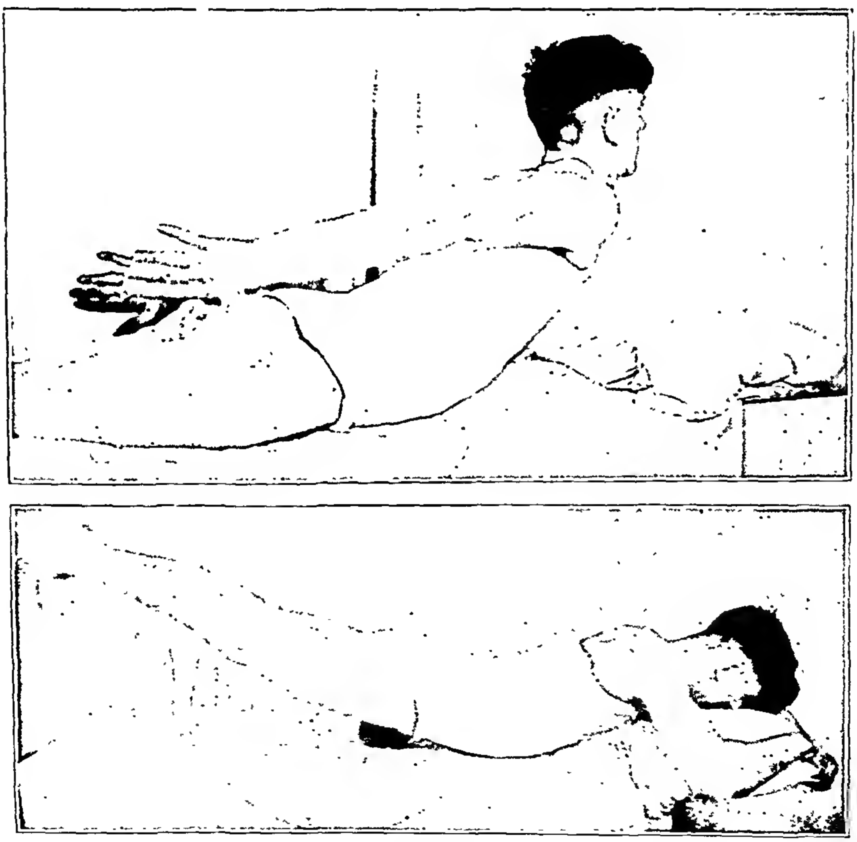


Fig. 4

Exercises for the erector spinae and for the abdominal musculature are practised throughout the period of immobilization.

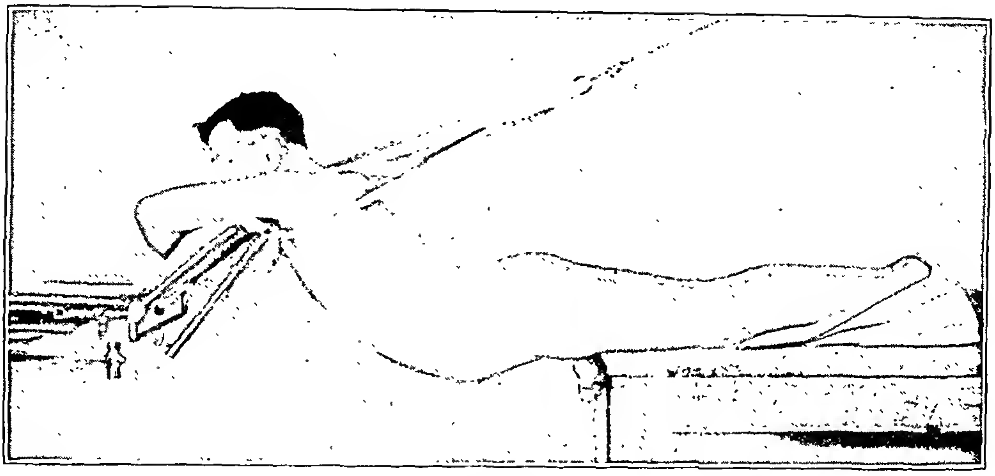


Fig. 5
Reduction of fractures in the lumbar region.

means of securing hyperextension and it is true that when this is used the increased abdominal support relieves the strain frequently complained of in this region. But it is this very support which reduces the efficacy of the method. The hammock, by preventing the trunk from sagging forward, limits hyperextension of the lumbar spine. Since reduction of the fracture was frequently incomplete, the method has been discarded in lumbar fractures, in favor of the shoulder sling.

REDUCTION OF HIGH DORSAL FRACTURES

The most difficult region of the spine in which to secure reduction of crush fractures is the upper dorsal area (first to eighth dorsal vertebrae).

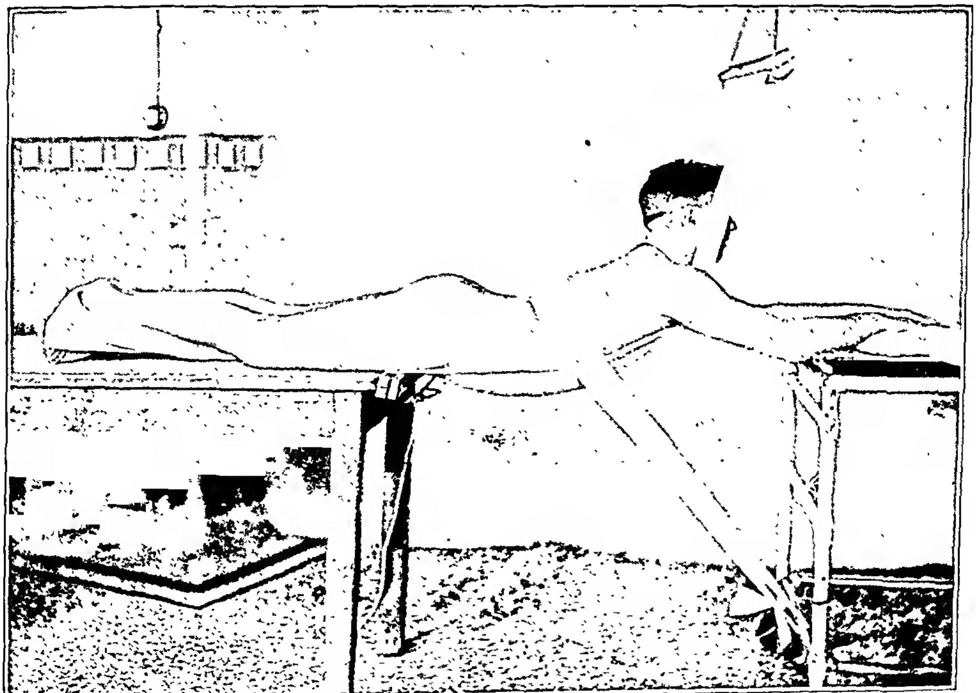
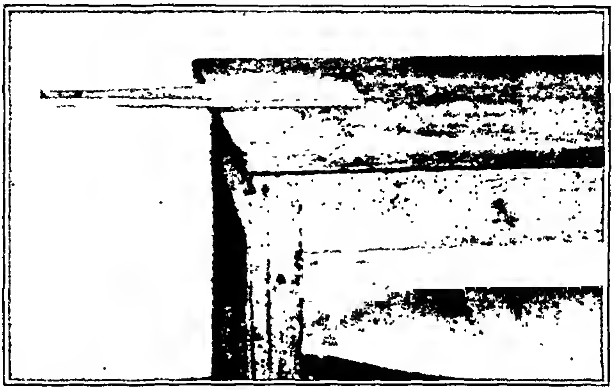


Fig. 6
Reduction of fractures in the dorsal region.

The success of reduction by hyperextension depends on the tremendous force which is localized to the fractured vertebra by movement of the long levers of the segments of spine above and below the fracture. But there is normally no hyperextension in the dorsal region and the center of this movement is in the lumbar area of the spine. A fractured upper dorsal vertebra lies, therefore, in the middle of one of the arms of leverage instead of at the junction of the two. Almost the whole of the energy of the hyperextension movement is concentrated in the lumbar area and



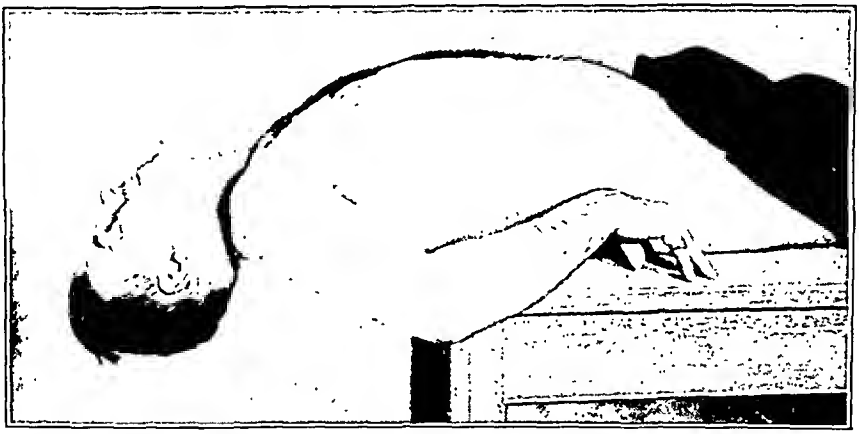


Fig. 7

Reduction of fractures in the cervical region.

practically none is transmitted to the upper dorsal area.

In practice we find that reduction cannot be effected if the lumbar spine is allowed free hyperextension movement, and it is necessary to fix the spine at or just below the level of fracture before hyperextension is performed. This can be done by means of a strong bandage tied down to the foot of the table in front of the patient. Hyperextension is then applied by means of a shoulder sling or ventral hammock (Fig. 6). In the high dorsal fracture the hammock is preferable to the sling, because it is now desirable to limit lumbar hyperextension, and, moreover, the hammock maintains full extension of the head and cervical spine.

REDUCTION OF CERVICAL FRACTURES

Exactly the same principles of treatment apply to crush fractures

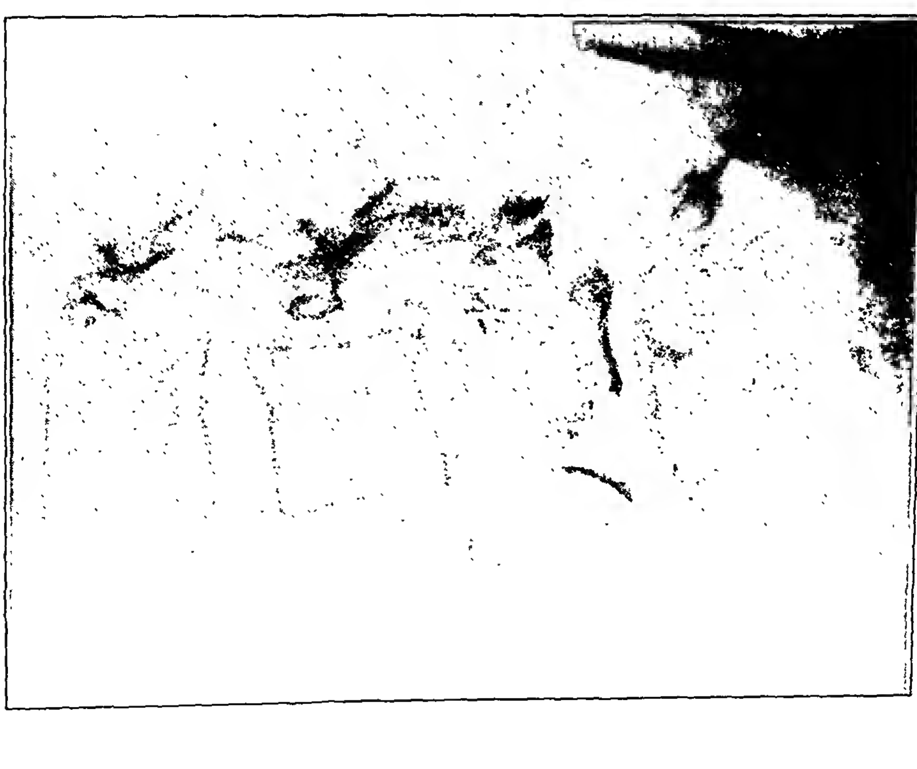


Fig. 8-A
Comminuted hyperflexion fracture. Before reduction.

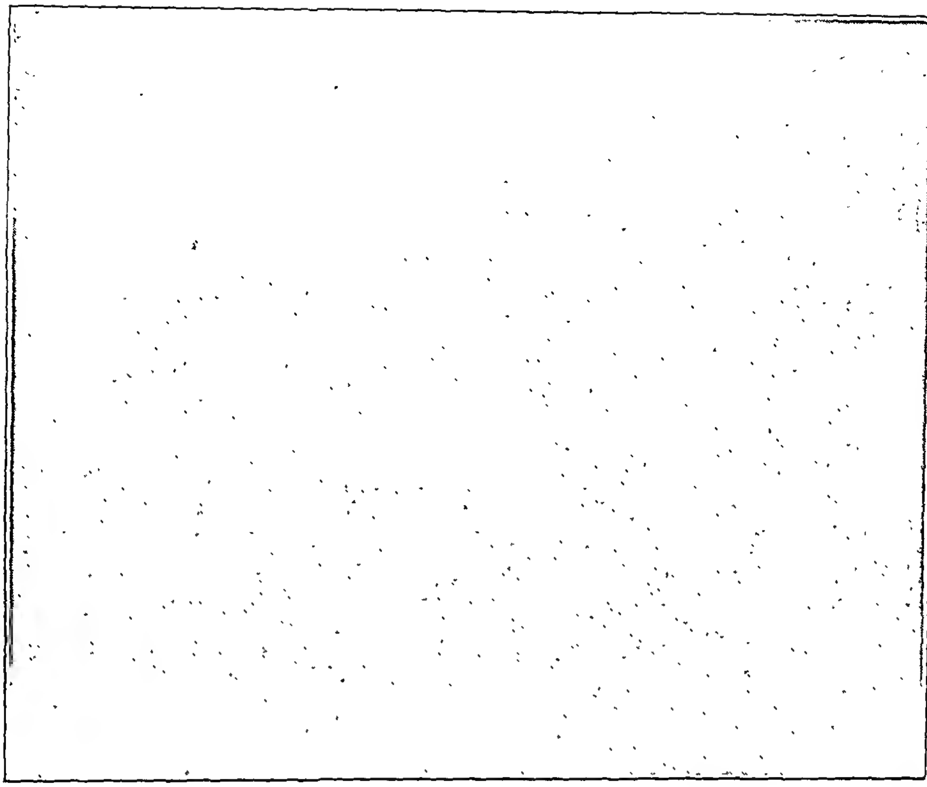


Fig. 8-B
After reduction (through plaster).

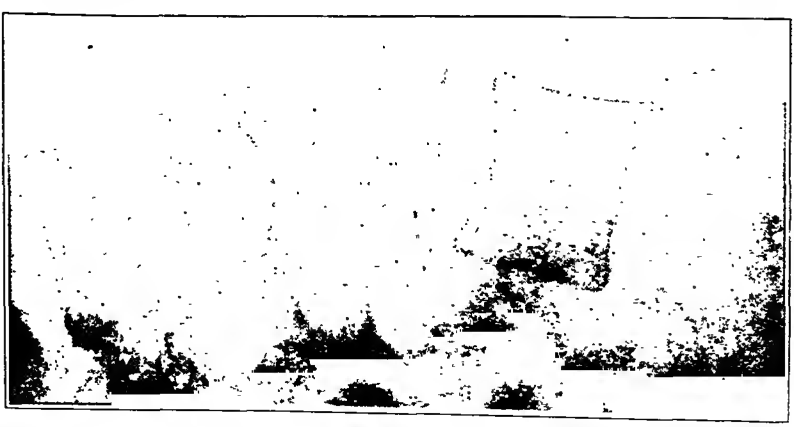


Fig. 9

Comminuted hyperextension fracture. This is the only type of spinal fracture in which hyperextension is contra-indicated.

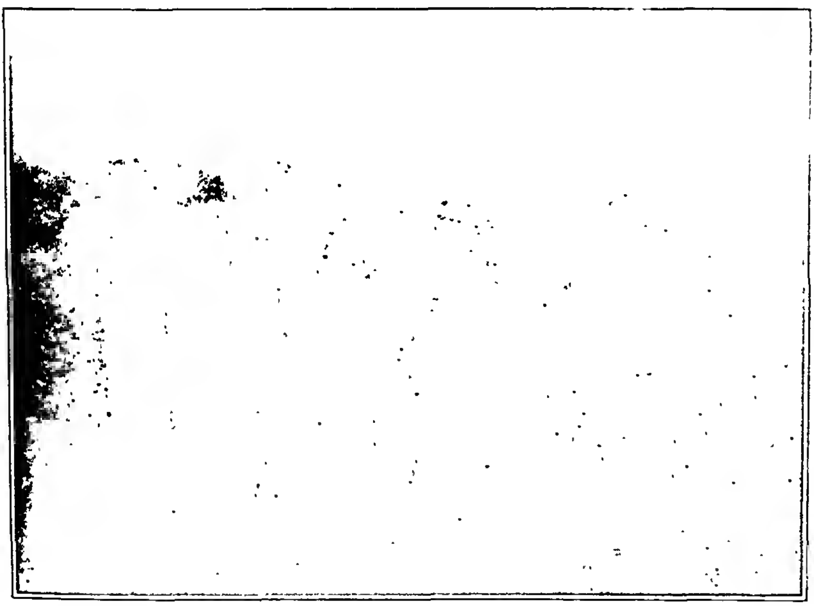


Fig. 10-A

Fracture dislocation with paraplegia. Before reduction.

Fig. 10-B

Five months after reduction. Note the slow rate of consolidation. (Dr. Isaac's case.)

and dislocations of the cervical vertebrae. Hyperextension can most easily be secured with the patient lying on his back. A long, narrow piece of wood is nailed to a table (Fig. 7) and padded, and the patient lies with the upper end of the wood at the level of fracture. The arms are held to one side by assistants and the head, neck, and upper trunk included in the plaster.

COMMINUTED FRACTURES OF THE VERTEBRAL BODY

Comminuted Hyperflexion Fracture

Comminuted hyperflexion fractures can be produced by the pinching of one vertebral body between the anterior margins of the bodies above and below. A large segment is detached from the front of the fractured body and is squeezed forward like a pea from a pod. In such a case the upper surface of the fractured body may show an angular depression, corresponding exactly in size and shape to the anterior-inferior angle of the body above, and the lower surface may show an angular depression corresponding to the anterior-superior angle of the body below (Figs. 8-A and 8-B). This represents the first degree of a comminuted hyperflexion fracture; but, if the force continues, the body will be more completely broken up and fragments may be displaced a considerable distance forward (Figs. 10-A and 10-B).

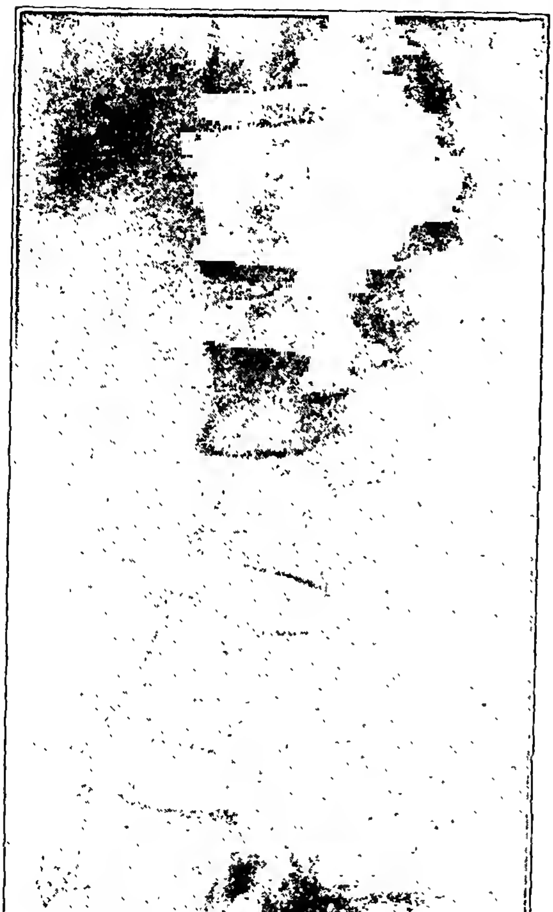


FIG. 11-A

Fracture dislocation with paraplegia. Before reduction.

Even in such cases the tension on the anterior common ligament, which becomes tightly stretched in full hyperextension, suffices to retract the fragments to their normal position, and surprisingly accurate reduction is effected.

Comminuted Hyperextension Fracture

It is important to recognize that a comminuted fracture of the vertebral body can be produced by hyperextension force. The vertebral bodies are so firmly attached to each other by the anterior common

ligament and the intervertebral disc, that a hyperextension strain leaves the ligamentous structures uninjured and breaks up the vertebral body. The posterior half of the body remains intact, but the anterior half separates into upper and lower quadrants. The upper quadrant is tilted upward by the traction of the ligament above, and the lower quadrant is tilted downward by the traction of the ligament below (Fig. 9).

Only one case of this type was seen in a series of 200 recent and old vertebral-body fractures, but, despite the extreme rarity of the injury, it is important that it should be recognized, since it provides the only exception to the rule that every vertebral-body fracture demands treatment by hyperextension.

Fig. 11-B

After reduction. (Full recovery from paraplegia, but permanent Babinski response.)

FRACTURES WITH PARAPLEGIA

When a crush fracture or fracture dislocation of the spine is complicated by paraplegia (Figs. 10-A and 10-B), the paralysis may be due on the one hand to transection of the cord, or on the other hand to simple contusion or compression. Although it is true that the transected cord is irrecoverable, there can be no doubt that a certain proportion of recoverable paraplegias become irrecoverable, owing to continued compression and anaemia. It is impossible to differentiate between the two types of paralysis, either clinically or roentgenographically. It is obvious, therefore, that in every case immediate steps should be taken to relieve the pressure. Laminectomy, either early or late, is a useless procedure, because, apart from the exceptionally rare cases of depressed fracture of the neural arch, the pressure is in front of the cord. On the other hand, immediate reduction of the displacement by hyperextension relieves any further compression and allows revascularization of the injured area. Even where the cord is irreparably damaged, the treatment has very greatly facilitated the problem of nursing, for the patient can be turned in comfort at regular intervals and pressure sores are avoided. Provided that the reduction is effected without anaesthesia, there is no risk of increasing the cord pressure, and, in

some cases at least, the treatment makes the whole difference between permanent paralysis and complete recovery. In one patient with complete paraplegia from which he recovered, the Babinski response remained permanently (Figs. 11-A and 11-B), and in another case there

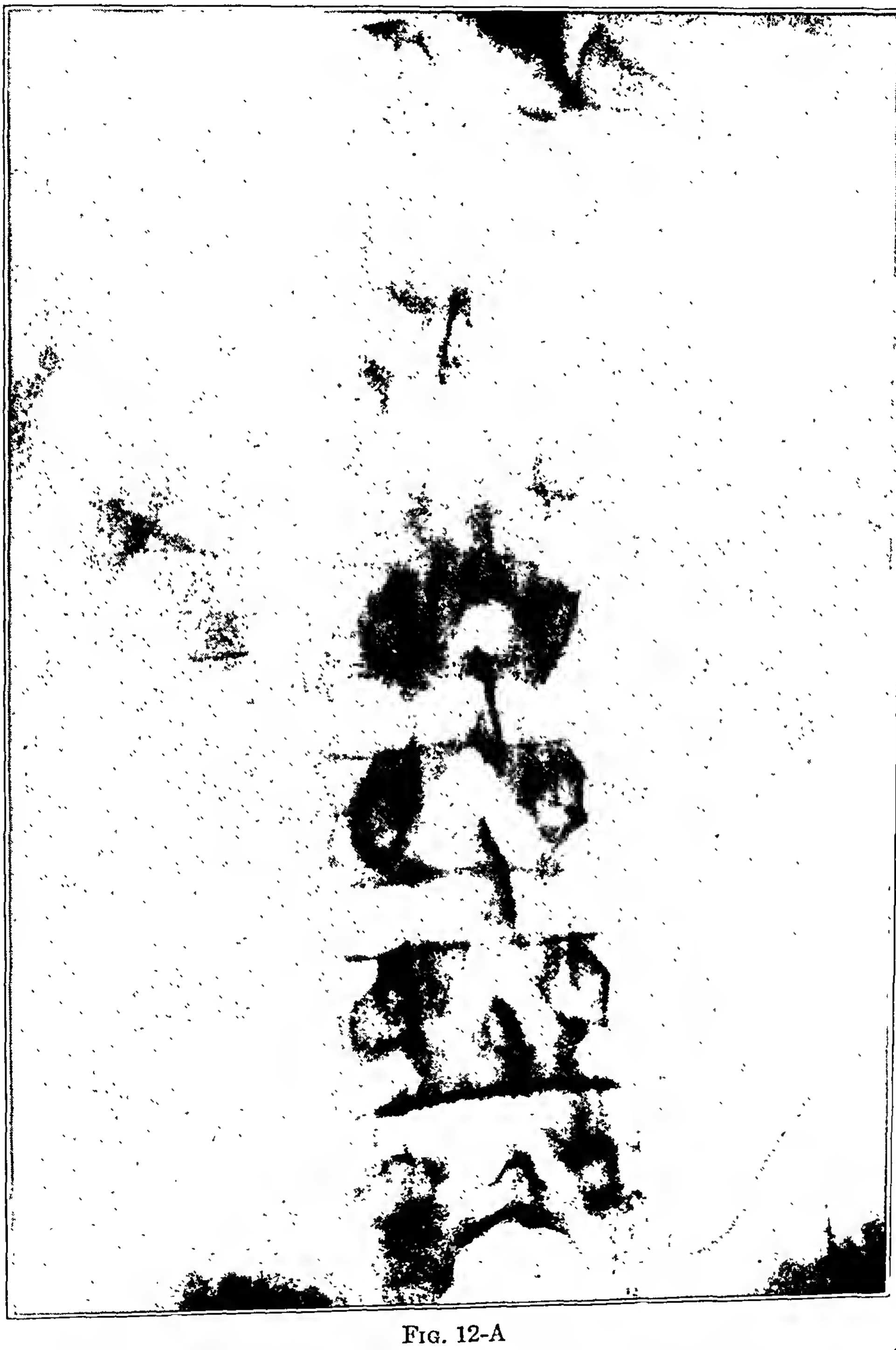


Fig. 12-A

Compression fracture with dislocation of interarticular joint and fracture of pedicle. Roentgenograms taken within half an hour after injury, before treatment was commenced. Despite the relatively slight displacement shown, the cord had been transected, proving that the deformity had been spontaneously reduced.

was permanent slight spasticity of which the patient was unaware. It is clear that in both of these cases there has been a much more severe injury than simple contusion or "concussion" of the cord and it is reasonable to assume that the recovery was attributable to the relief of compression by reduction within an hour or two of injury.

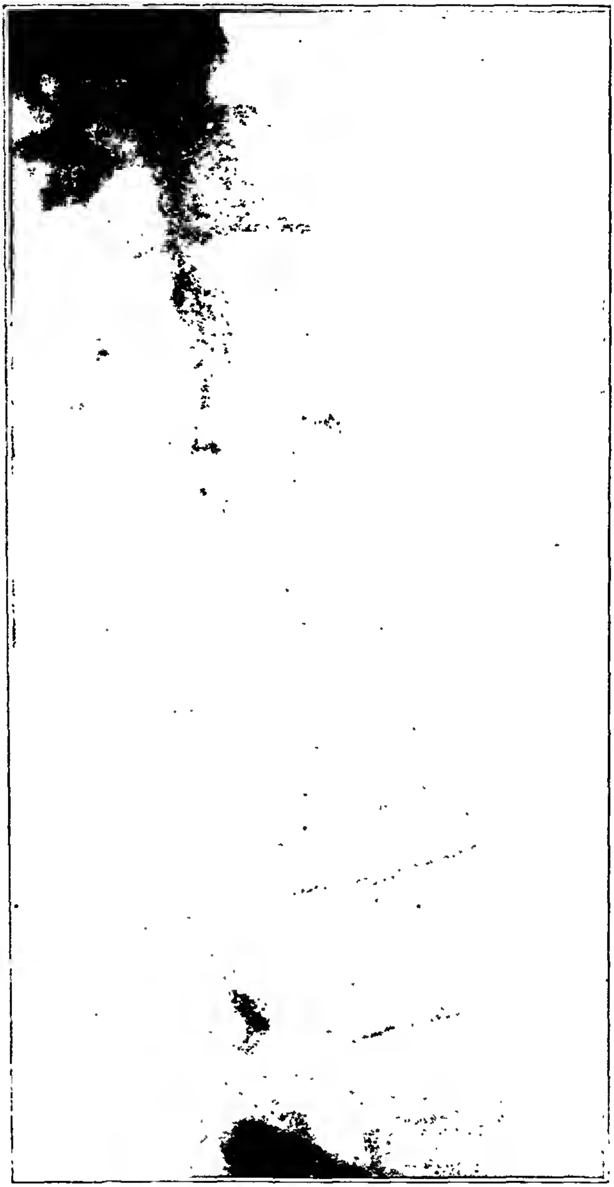


FIG. 12-B
Lateral view taken immediately after injury.

The prognosis in fracture dislocations in the upper dorsal area with paraplegia is very poor, but is good in fracture dislocations in the lower dorsal and lumbar regions. In the upper dorsal spine there is relatively little space within the vertebral canal, so that gross displacement is almost invariably associated with transection of the cord. Immobility of the chest from intercostal paralysis increases the difficulties, and the shock is always greater. Moreover, there is frequently intradural hemorrhage accounting for the paraplegia which may develop after injury to the cervicodorsal junction in the absence of fracture or dislocation. In the lumbar region, on the other hand, there is more space within the vertebral canal, and many fractures occur below the level of the cord itself.

Twenty-one cases of fracture dislocation with paraplegia have been reduced. Nine patients died, and of the twelve surviving cases there was

complete recovery from paralysis in ten. The statistics are more illuminating when the high dorsal fractures are differentiated from the low dorsal and lumbar injuries.

TABLE I

FRACTURE DISLOCATIONS WITH PARAPLEGIA

	Cases	*Death*	*Complete Recovery*	*Permanent Paralysis*
Cervical fractures	1	–	1	–
High dorsal fractures	8	7	1	–
Lumbodorsal fractures	12	2	8	2

FIRST AID TREATMENT

Only the surgeon who has himself reduced fractures of the spine and has seen the kyphos "melt" before his eyes, smoothly disappearing as the spine was hyperextended, can appreciate the unusual power of the pair of levers represented by the segments of the trunk above and below the injury. Many fractures have been spontaneously reduced before the surgeon has seen them. As the spine recoiled from the position of acute hyperflexion and as the patient was laid flat by onlookers, the degree of deformity was spontaneously reduced. Figures 12-A and 12-B are the roentgenograms of such a case taken within half an hour after the injury before any treatment was given. The degree of compression of the fractured vertebral body is relatively slight, and yet the cord was completely transected, proving that the displacement had originally been much more severe than is shown in the roentgenogram. There can be little doubt that "Kümmell's disease" of the spine is another example of spontaneous reduction of relatively slight crush fractures of the vertebral body with subsequent absorption owing to inadequate immobilization. In many of our postreduction roentgenograms it would be quite impossible, without the evidence of earlier roentgenograms, to say that there had been any fracture at all.

Since very gentle hyperextension movement in a conscious patient will reduce a fracture dislocation of the spine, it is obvious that the converse is also true, and that gentle hyperflexion movement will increase the displacement and may cause further injury by compression of the cord. For this reason, when a patient with a fracture of the spine is being lifted on to a stretcher, or from a stretcher to a bed, he should always be *lifted face downwards*, so that any sagging there may be between the points of support will hyperextend and not hyperflex the spine. This is particularly true in mine shafts where an injured man may be carried considerable distances over broken irregular ground, and in England instructions in "face-down transport" have been issued to every mine. Similar orders have been given by the Royal Army Medical College, and by the St. John's Ambulance Brigade in Ireland.

SUMMARY

The results of treatment of eighty cases of crush fracture of the spine by the author's method are reviewed. The method requires no special apparatus, no skilled assistance, no manipulation of the spine, and no anaesthetic.

Treatment is ambulatory throughout. The risk of lung complication and functional disorder is minimized. The method is equally applicable to the difficult high dorsal fractures, and to cervical fractures.

Comminuted fractures are easily reduced. They consolidate slowly and require six months' immobilization.

Fractures with paraplegia demand immediate reduction without anaesthesia. This routine has replaced laminectomy for spinal fracture. Recovery is secured in seventy per cent. of low dorsal and lumbar fractures, but is rarely seen in high dorsal fractures.

The only contra-indication to hyperextension treatment, is the very rare comminuted hyperextension fracture of the vertebral body.

Many fractures have undergone spontaneous reduction before being seen by the surgeon. After reduction they may be roentgenographically indistinguishable from normal. Herein lies the explanation of "Kümmell's disease".

Face-down transportation is essential in first aid treatment.

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CORRECTION OF SEVERE EQUINUS DEFORMITY

BY LEO MAYER, M.D., NEW YORK, N. Y.

Despite the advance in our treatment of club-foot, due in great p to the work of Schultze in Germany, Brockman in England, Gaensl Hoke, and Kyte in America, in my experience, one element of the defor ity has proven extremely difficult of thorough correction. This is equinus position of the os calcis. I do not, of course, refer to the m grade of equinus frequently present at birth or during the first few mont Usually this is easily corrected by manual pressure either with or with tenotomy of the Achilles tendon.

The type of equinus to which I refer is the severe grade found in calcitrant cases of club-foot where, despite attempts at correction, t os calcis is inclined downward at an angle of 130 degrees or more. equally severe grade of equinus is also occasionally found in paralytic fe which have not been properly supported. The difficulty in correcti this malposition, even after division of the Achilles tendon and poster capsulotomy, is due to the inadequate methods hitherto available of gri ping the os calcis and pulling down the posterior tubercle. Upwa pressure against the sole of the foot, instead of correcting the deformit adds to it by creating a rocker sole with the calcaneocuboid joint at t most dependent portion.

FIG. 1

Kirschner wire is being introduced through the posterior portion of the os calcis.

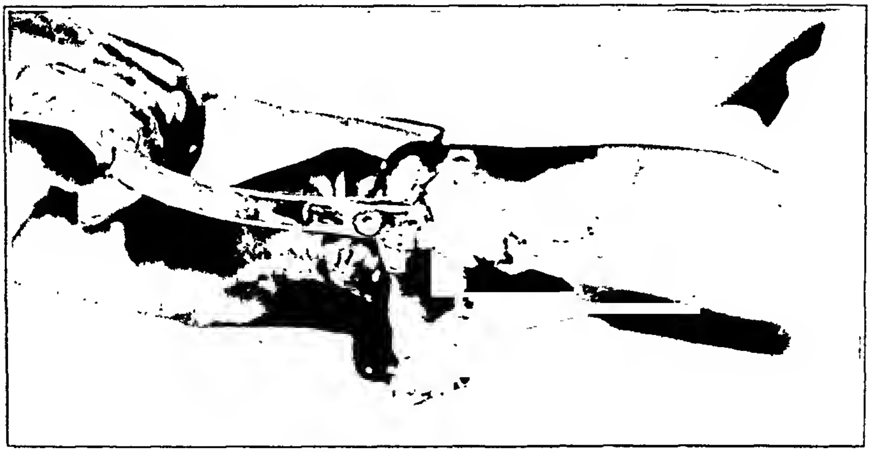

FIG. 2

Downward traction is being made on the Kirschner wire through the tension device attached to it. At the same time firm pressure is being made against the calcaneocuboid joint.

It is for this stubborn, resistant type of equinus deformity that the following method has been evolved. It is applicable at any age and to any type of equinus except that due to a bony ankylosis. It consists essentially of the insertion of a nail or wire through the posterior portion of the os calcis by means of which, following the tenotomy and posterior capsulotomy, the posterior tubercle of the os calcis can be pulled downward and the anterior portion of the os calcis shoved upward.

FIG. 3

Plaster has been applied while the foot is held in corrected position. The tension device is still in place.

Fig. 4

Fig. 4. Patient S. B., eighteen months old. Congenital equinovarus deformity with a rocker sole, due to attempts to correct the equinus by manual pressure.

Fig. 5

Fig. 5. Roentgenograms of Patient S. B., shown in Fig. 4.

Fig. 6–A

Fig. 6–B

Patient S. B. Photographs showing the correction of the equinus deformity at the time of first dressing and removal of the wire five weeks after its insertion.

The steps in the technique are as follows: The foot is prepared as for a major operative procedure. Subcutaneous division of the Achilles tendon is then done. With a long thin tenotome the posterior portion of the capsule of the upper and lower ankle joint is divided. In a mild case correction is now possible by means of manual pressure. In the resistant case, however, the os calcis does not alter its position, as shown in control x-ray pictures. To grip the os calcis a thin Steinmann nail or a Kirschner wire is driven through its body as near the posterior tubercle as possible

Fig. 7

Patient S. B. Roentgenogram of the right foot after removal of the wire. The left foot, not shown in the illustration, shows corresponding correction.

Fig. 8

Roentgenogram showing severe equinus deformity in case of infantile paralysis (Patient M. V., aged two and a half years). This patient had had two previous tenotomies and manipulations without correction of the equinus position of the os calcis.

(Fig. 1). If wire is used, an appropriate device must be applied to span the wire under tension (Fig. 2). A recent improvement in technique is the use of a thin, rustless steel nail which does not require the tension device and leaves a much smaller opening in the bone than the Steinmann nail. When the nail or wire is in place, it is grasped by the operator and

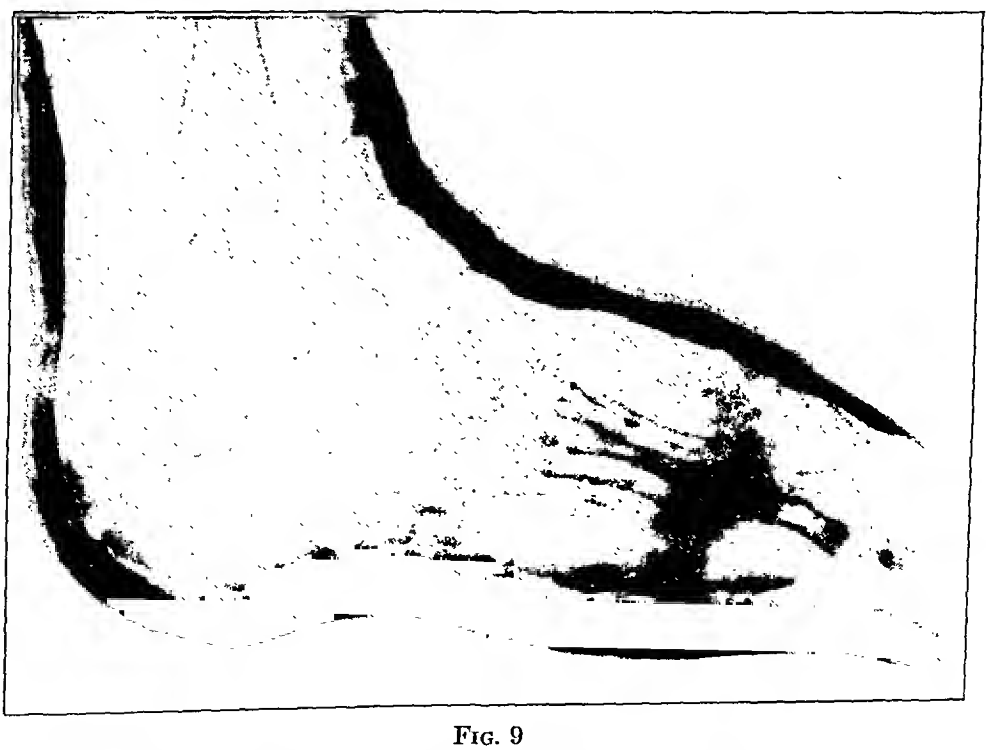

Fig. 9

Roentgenogram of Patient M. V. after the Steinmann nail had been removed. The foot still encased in plaster shows complete correction of the deformity.

Fig. 10

Roentgenogram showing equinus deformity in a patient four years of age. (Patient B. N.)

strong downward pressure is made upon the posterior portion of the os calcis, while at the same time upward pressure is made against the calcaneocuboid junction (Fig. 2). By this means the tendency to rocker

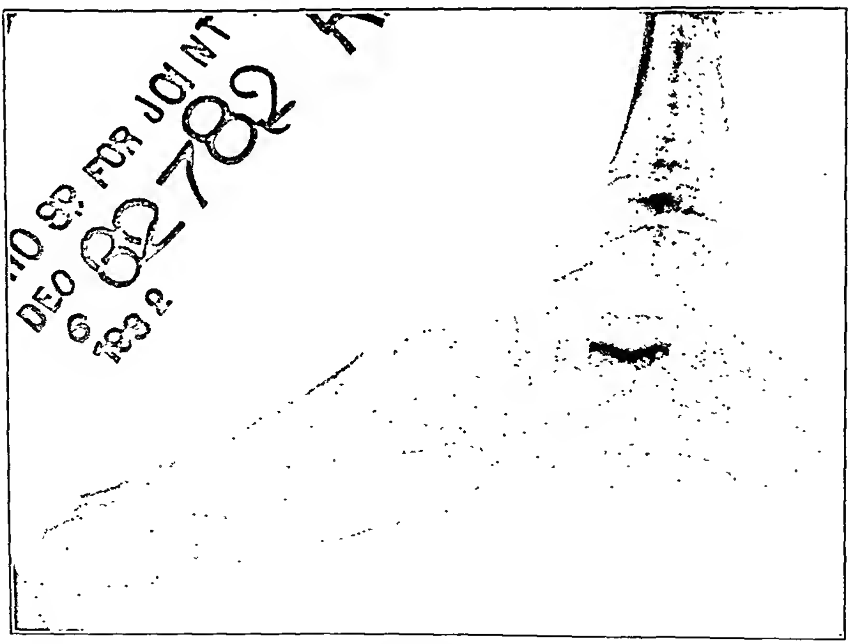

Fig. 11

Patient B. N. Roentgenogram showing position of the os calcis after correction.

sole is completely corrected and the equinus tilt of the os calcis completely overcome. In club-foot the inversion of the os calcis can be converted into eversion by an appropriate tilting of the nail or wire. To facilitate correction one of my associates, Dr. Telson, has devised a lever which can be attached to the Kirschner wire. This lever exerts upward pressure against the calcaneocuboid joint and at the same time depresses the posterior portion of the os calcis. Its one disadvantage is that it is almost too powerful and, unless great care is used, it may cause a fracture of the lower end of the tibia and fibula. When complete correction has been made, the foot is encased in plaster-of-Paris which includes the nail or the wire (Fig. 3). If the wire is used, two small, metal clamps are applied, one on each side, to prevent the wire from slipping. The plaster should be left in place for a *minimum* period of four weeks. When the deformity is severe, the original plaster may be left on for a period of six weeks. In no instance has the presence of the nail or of the wire resulted in a permanent fistula. In young children the opening in the bone closes with great rapidity and invariably at the time of the removal of the second plaster, four weeks after the first, the bone opening has been found completely closed.

Thus far fifteen cases have been treated by this method. The age of the patients has ranged from nine months to four years. In each instance the patient had been under treatment at the hands of a skilled orthopaedic surgeon who had been unable to correct the equinus deformity. Two of the cases were paralytic in origin; the others were congenital. In all complete correction of the deformity has been secured.

SUMMARY

A new method of overcoming severe equinus deformity in cases of congenital club-foot or of paralytic equinus is presented. This consists of driving a nail or wire through the posterior part of the os calcis, by means of which the os calcis can be firmly grasped. The nail is included in the plaster-of-Paris applied at the time of manipulation. A six weeks' period of immobilization is usually sufficient to correct the most marked degree of equinus.

THE EXTENT OF SKELETAL CHANGE AFTER AMPUTATION

BY T. WINGATE TODD, F.R.C.S., AND C. G. BARBER, M.A., M.D.,
CLEVELAND, OHIO

Anatomical Laboratory, Western Reserve University.

INTRODUCTION

In two previous reports [1,2] we have described the local features of healing bone stumps in amputated limbs.

Disuse or impairment of function is accompanied by decrease in weight and density of the bones. In skeletons from the Hamann Museum, obtained from persons who had suffered amputation of arm or leg, we find this decrease evident even in the uninjured bones of the mutilated limb. The rarefaction is much more extensive than that postulated by Leriche and Policard [6] for the traumatized and periosteum-stripped area. Mayer and Wehner [8] hoped to substantiate this more extensive resorption by studies of bone growth *in vitro.* Leriche and Policard [7] imply it in their description of healing in fractured bones.

In a quantitative determination of mineral resorption in the bones of mutilated limbs, one must beware of the variability in dimensions and weight of bones on the two sides of the same skeleton. This variability is expressed in Table I for which we are indebted to Ingalls [4].

Our measurements of dimensions are based also on those of Ingalls [3].

Tables II and III give site, number, and percentage of the amputations at our disposal. Amputations of the upper extremity comprise twenty per cent. of the total. This is about the percentage found in any large hospital practice[5].

AMPUTATIONS OF THE LOWER EXTREMITY
BONE WEIGHTS AND DIMENSIONS

The Femur

Our measurements do not indicate any reduction in dimension of the femur on the side of amputation below the knee, but there is an obvious reduction in femoral weight (Table IV) though it is inconstant. In only two of our skeletons was the femur heavier in the amputated limb. One of these (No. 864) was obtained about eleven days after amputation. The other (No. 1177) had a club foot on the sound limb. There is no relationship in age of patient to the decrease in femoral weight which, on the average in our fourteen examples, is thirteen per cent. of the weight of the femur on the sound side (Table IV).

No. 238 and No. 1697 suffered amputation through both legs. In each the femur on the side of the shorter stump was the lighter bone.

The Patella

The patella in general follows the femur. Dimensions are not reduced and weight, though diminished, falls erratically. Nevertheless the

TABLE I

100 Male White Adult Skeletons

Bone	Mean Weight (Grams) Right	Mean Weight (Grams) Left	Range (Grams) Right	Range (Grams) Left
Clavicle	27.0		15–41	
Scapula	77.7		40–115	
Clavicle and scapula	104.7	103.0	55–156	54–168
Patella	16.1		8–29	
Tibia, fibula, patella	342.0	338.9	213–543	213–530
Femur	458.9	460.7	266–695	281–642
Innominate	223.7	227.1	115–352	117–382

Statistical Distribution

	Standard Deviation Right	Standard Deviation Left	Coefficient of Variation (Per Cent.) Right	Coefficient of Variation (Per Cent.) Left
Clavicle	5.3		19.6	
Scapula	13.0		16.6	
Clavicle, scapula	17.5	17.5	16.7	17.0
Patella	3.8		24.0	
Tibia, fibula, patella	60.2	63.6	17.7	18.8
Femur	76.4	74.7	16.6	16.2
Innominate	45.8	45.9	20.5	20.2

average diminution in weight is again thirteen per cent. of the weight of the bone on the sound limb.

In No. 864 and No. 1177 the patella, like the femur, was heavier on the sound limb. In No. 262, obtained five or six days after amputation, and in No. 1170, with no obvious reason, patellar weight was identical with that of the sound limb.

The Innominate Bone

Maceration of the innominate must be carried out with particular care, for faulty preparation would invalidate the results. No reduction in dimensions was found. Diminution in weight reaches an average of seven per cent. of the weight of the bone of the sound limb in our fourteen amputations below the knee. In the fourteen amputations through the thigh the diminution in weight averages eleven and five-tenths per cent. (Table IV). It is significant that, generally speaking, the further a bone is removed from the amputation site, the less is its functional involvement as shown by postoperative loss of weight.

TABLE II

Site	Number	Percentage
Thigh	14	35
Leg	18	45
Upper arm	6	15
Forearm	2	5

From Table IV one may not assume indefinitely progressive loss of weight. It is conceivable that restoration of weight may later take place or that some resultant irritative condition, such as a neurofibroma, may influence the course of progress. In a later communication we shall show this latter hypothesis to be unjustified.

ROENTGENOGRAPHIC CHANGES

Whereas it is difficult to make an adequate study of changes in bone texture by roentgenograms of the living, this series of skeletons permits a satisfactory analysis.

Within a few days after amputation rarefaction begins in all the bones of the mutilated extremity, and rapidly increases for a period of some fourteen days, after which the texture appears to stabilize itself. The architectural pattern remains unchanged.

The progressive course of rarefaction is well seen in the femoral neck and in the os innominatum around the acetabulum, in the ischium, and the anterior iliac spines.

The following is a brief sketch of our findings.

No. 262, a male white of forty years, five to six days after amputation below the right knee, shows no apparent rarefaction.

No. 864, a male negro of forty-eight years, about eleven days after amputation below right knee, shows no change in bone weight (Table IV). There is a loss of finer trabeculae which surround and to some extent obscure the primary architectural pattern. This rarefaction occurs in the areas of, or close to, attachment of muscles of the leg,—namely both trochanters, the neck, and the femoral head.

TABLE III

Multiple Amputations Included in Table II

Site	Number
Right thigh and left leg	1
Left thigh and right leg	1
Both legs (below knee)	2
Both upper arms	1

TABLE IV

CHANGE IN WEIGHT EXPRESSED IN PERCENTAGE OF THE SOUND SIDE

(— signifies weight less than on sound side; + signifies greater weight)

Skeleton No.	Site of Amputation	Time Since Operation	Femoral Difference	Patellar Difference	Innominate Difference
262	Right leg	5 or 6 days	— 7.0	0.0	— 5.0
864	Right leg	11 days	+ 2.0	+ 0.5	— 2.0
319	Left thigh	13 days			+ 0.5
1585	Right thigh	17 days			—12.5
952	Right thigh	Not many weeks			—20.0
1227	Left thigh	Recent			— 1.8
1170	Right leg	Long standing	—16.0	0.0	+ 3.0
1800	Right leg	" "	—29.0	—23.0	— 0.2
142	Right leg	" "	—14.0	—37.0	— 3.8
318	Right leg	" "	—18.0	—12.0	— 5.3
1132	Right leg	" "	—26.0	—24.0	— 8.5
1177	Right leg	" "	+ 0.6	+22.0	—14.0 (Club foot, left)
1299	Left leg	" "	— 5.0	—15.0	—19.0
266	Left leg	" "	—32.0	—46.0	—12.0
1995	Left leg	" "	—15.0	—12.0	— 3.3
1686	Right thigh	" "			— 9.0
1217	Right thigh	" "			—16.6
310	Stokes-Gritti	" "			—29.0
1384	Right thigh	" "			—32.0
1550	Left thigh	" "			+22.0
1519	Left thigh	" "			— 1.7
1332	Left thigh	" "			—16.0
1991	Left thigh	" "			—14.8
Multiple Amputations					
1472	Right thigh, Left knee	Long standing			— 1.5
1697	Both legs	" "	— 2.0	—15.0	— 3.0
238	Both legs	" "	— 6.6	— 9.0	— 7.5
1291	Right leg, Left thigh	" "			—15.0
1471	Left leg, Right foot	" "	—24.0	—10.0	—12.0

FIG. 1-A

Roentgenograms: amputation through right femur. W. R. U. 952. Male, white, aged forty years. Amputation through middle of shaft several weeks previously. Note quiescent uniform rarefaction in femur in contrast to active patchiness in the innominate bone.

FIG. 1-B

No. 319, a male white of fifty years, about thirteen days after amputation through the middle of the left thigh shows clarification of architecture in upper end of femur vividly recalling the detail characteristic of osteo-arthritis. There is also decreased density in the innominate bone between ischial spine and acetabulum and also, to a less extent, in both anterior iliac spines but nowhere else.

In No. 1585, a male negro of thirty-one years, about seventeen days after amputation through the middle of the right thigh, clarification extends beyond the areas just mentioned. It is now present also in femoral shaft and around acetabulum.

No. 952, a male white of forty years, several weeks after amputation through the right thigh, shows rarefaction (Figs. 1-A and 1-B) far more uni-

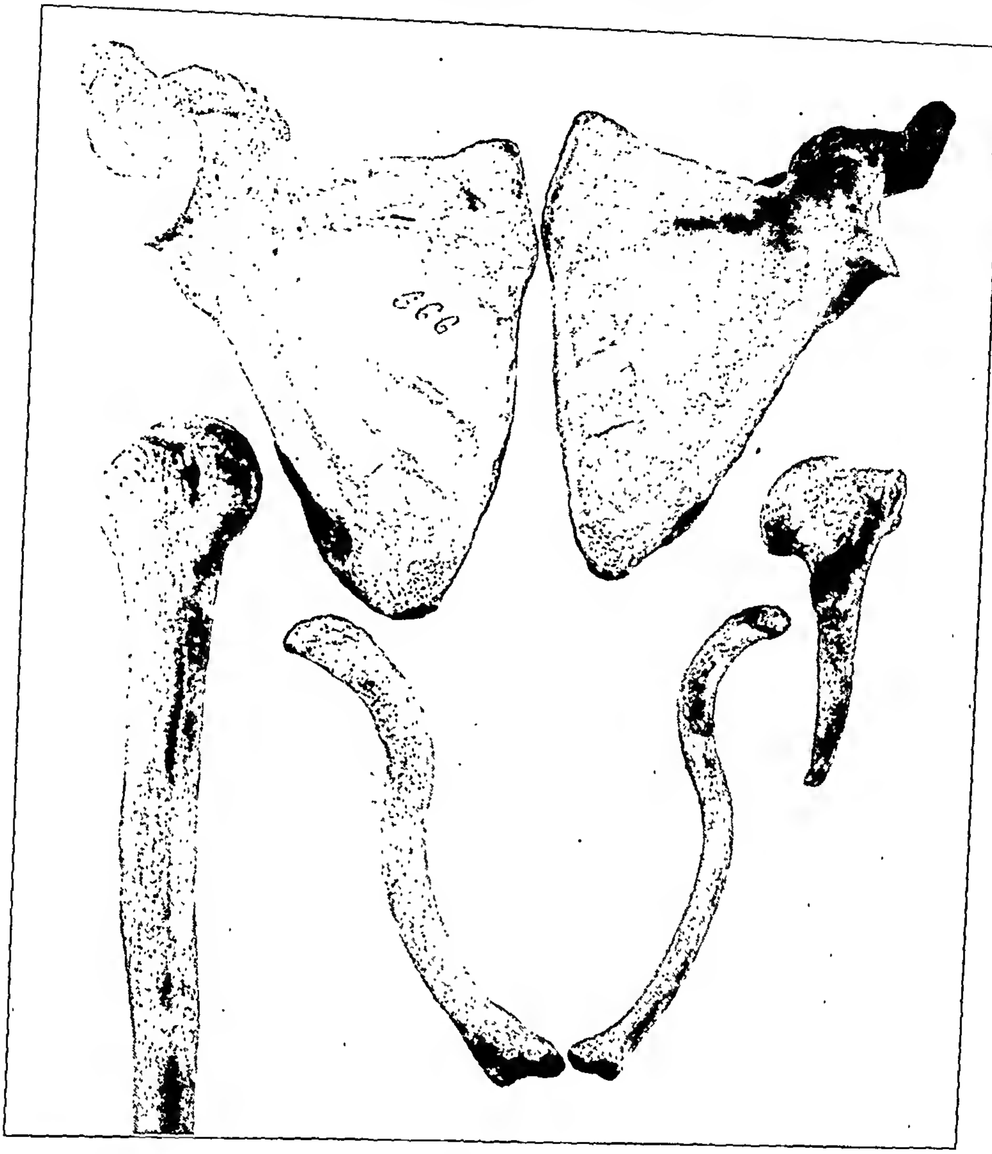

FIG. 2-A

Amputation through left humerus. W. R. U. 666. Male, negro, aged forty-four to forty-nine years. Photograph. Amputation at junction of middle and upper thirds of shaft. Marked gracility of humeral shaft remnant with atrophy extending to upper extremity of humerus, to scapula, and to clavicle.

form in the femur but still patchy in the innominate as it is in No. 1585.

No. 1519, a male white of seventy years, long after amputation through the left thigh, shows the general osteoporotic condition characteristic of senility, but there is, nevertheless, a distinct rarefaction on the mutilated side.

No. 1227, a male white of thirty-seven years, long after amputation through the middle of the left thigh, shows a texture in both upper femur and innominate bone approaching more nearly that of the sound side than in any of the foregoing except No. 262 and No. 864. Reconstitution has, therefore, taken place in this younger man, whereas it did not in the senile example, No. 1519.

No. 1332, a male white of about forty years, long after amputation

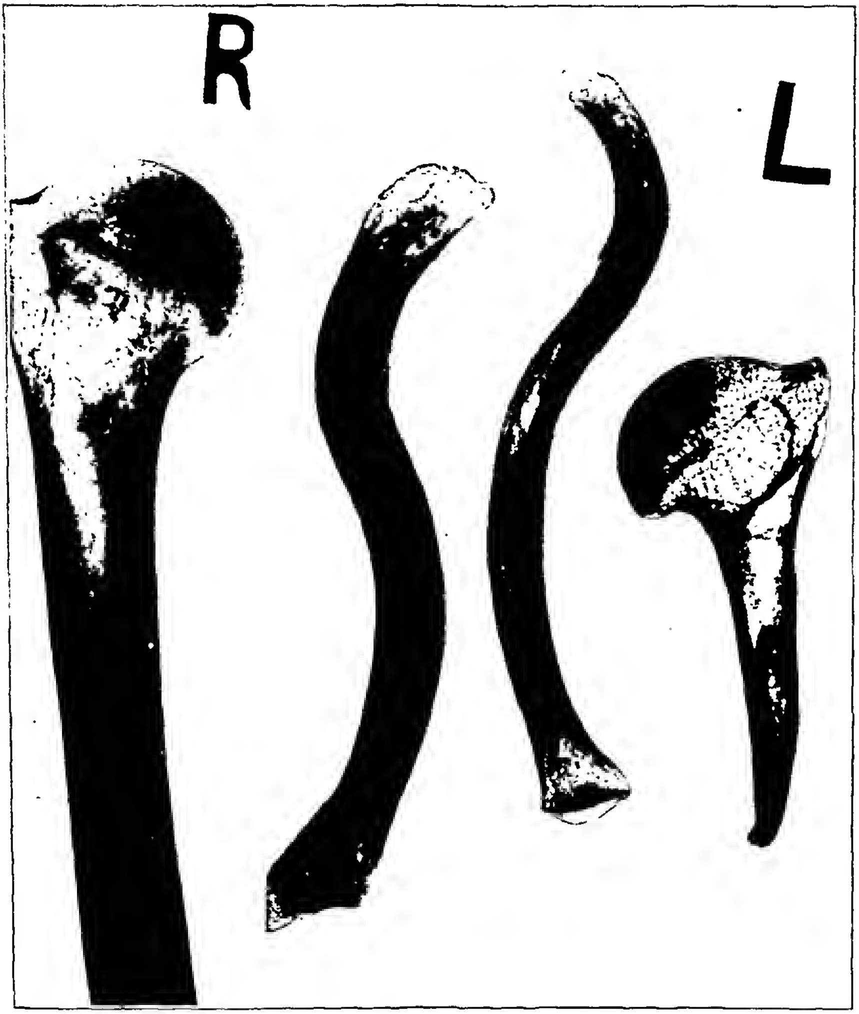

FIG. 2-B

Roentgenogram shows atrophic changes in humeral stump, scapula, and clávicle. Left clavicle and scapula are smaller and thinner than the right and the muscular ridges are much less pronounced.

through the lower left thigh, resembles No. 952 in the uniformity of rarefaction. Reconstitution is still imperfect.

In summary of the foregoing we may conclude that rarefaction, at first patchy but later more uniform, commences about ten days after operation and continues rapidly to about three weeks after operation, with eventual partial restitution of texture which may be hampered by the general osteoporosis characteristic of advancing age.

GROWTH OF THE MUTILATED FEMUR

In contrast to the course of growth in the humeral stump it is essential to present, from our files, the record of S. S. 2082, a lad of eighteen

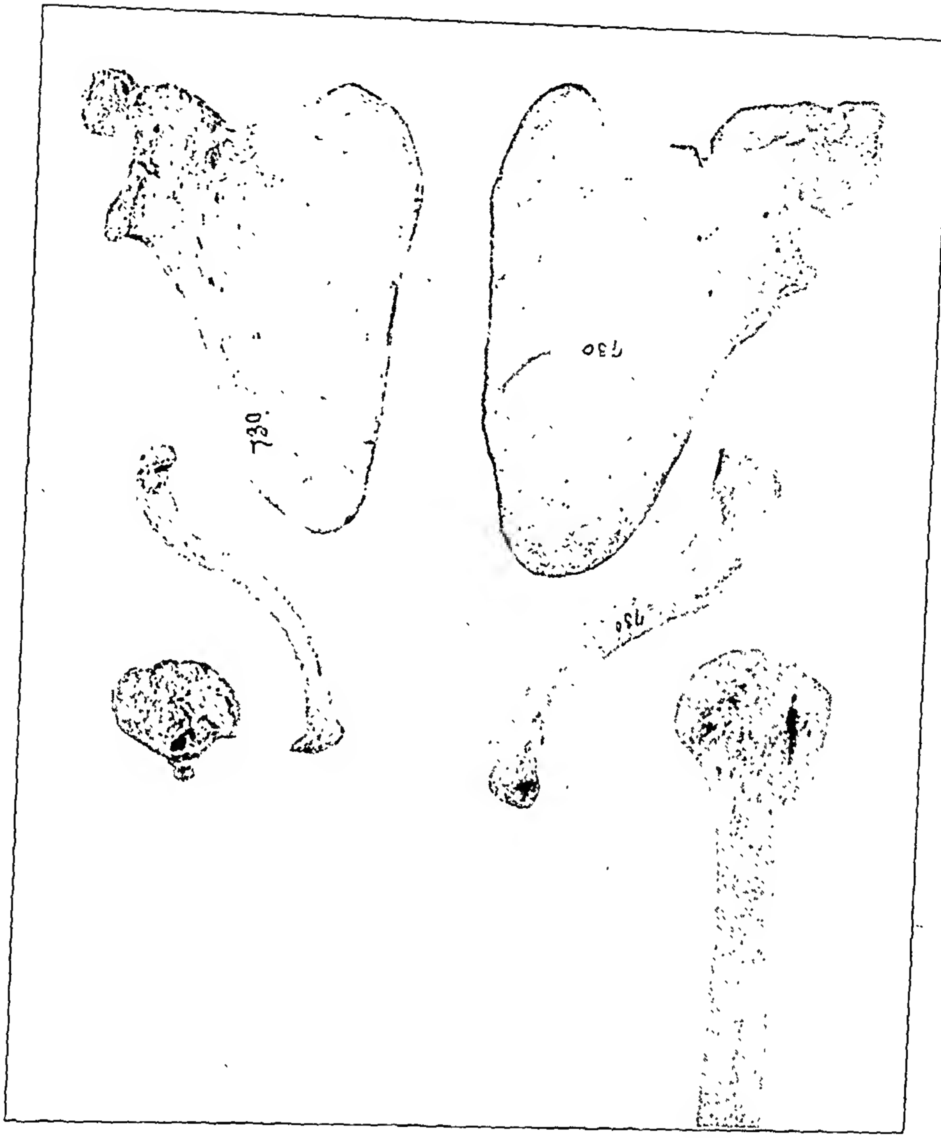

FIG. 3-A

Amputation through right humerus. W. R. U. 730. Male, white, aged fifty-one years. Photograph. Amputation through surgical neck. Very pronounced atrophy with collapse of specific bony outlines and disorganization of joint surfaces in *humeral* remnant, scapula, and clavicle.

years who suffered amputation through the upper right thigh *at four years*. Our roentgenograms of femora and pelvis in this boy, made in such a manner that the roentgenograms of the two sides could be superposed for comparison, show that, even at the end of adolescent growth, femoral head and neck are undiminished in dimension. There is, however, as one would expect, marked reduction in dimensions of both trochanters on the mutilated femur.

It appears, from this and similar cases in our experience, that the only growth defect suffered in a bone of the lower extremity, *mutilated* by amputation in childhood, is produced by the rarefaction and possibly the shrinkage of the bone scaffoldings for muscular attachment.

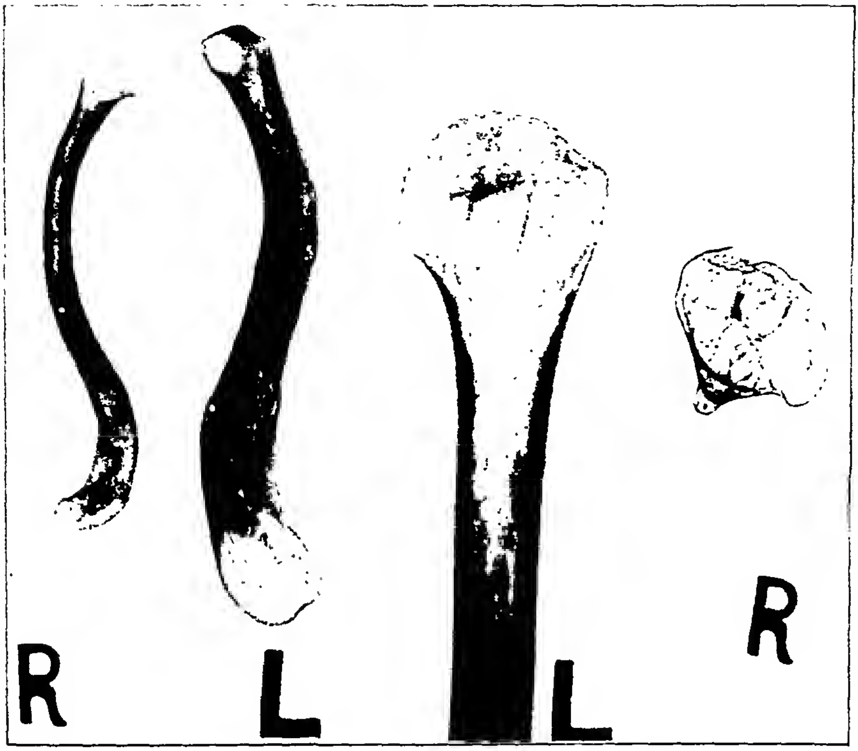

FIG. 3-B

Roentgenogram. Pronounced atrophy of clavicle and scapula. Humeral stump reduced to a mere shell of bone.

AMPUTATIONS OF THE UPPER EXTREMITY

A. Forearm

In our collection are two amputations through the forearm.

No. 1019, a male white of fifty-eight years, about fifteen days after amputation through the distal third of right forearm, shows characteristic patchy rarefaction throughout radial and ulnar stumps, humerus, scapula, and clavicle.

No. 593, a male white of forty years, long after amputation through upper third of left forearm, shows a uniform rarefaction in radial and ulnar stumps. It is also evident at both ends of humerus, but not in humeral shaft, in scapula, or in clavicle. In these bones the texture has evidently been partially restored although the example differs from No. 1019 in showing some reduction in weight of the humerus, scapula, and clavicle (Table V).

B. Upper Arm and Shoulder Joint

The effect of amputation above the elbow stands in sharp contrast with that seen after amputation through the lower limb or forearm, for we find ultimate reduction in dimensions of humeral stump, scapula,

and clavicle. Our six examples comprise one amputation through the shoulder joint and five through the humerus.

No. 468, a male white of fifty-one years, long after amputation through the left shoulder joint, shows disorganization of glenoid surface and a healed fracture of scapular blade. The scapula measures 175 millimeters in vertical length against the 182 millimeters of the right bone, and the left clavicle is singularly slender. There is relatively slight reduction in scapular weight (Table V).

No. 666, a male negro of about forty-five years, long after amputation through upper left humerus, shows marked reduction in humeral girth and atrophy of head and tuberosities (Figs. 2-A and 2-B). There is the characteristic rarefaction of humerus and this has spread to scapula and clavicle. In length the left scapula measures 155 millimeters against the 161 millimeters of the right bone; and the left clavicle, in length 170 millimeters, is six millimeters shorter than the right.

No. 730, a male white of fifty-one years, is the most pronounced example (Figs. 3-A and 3-B). Amputation occurred through surgical neck of the right humerus. Rarefaction has reduced the humeral stump to a mere shell. The vertical length of right scapula is 148 millimeters, whereas that of the left is 164 millimeters. Right clavicle measures 200 millimeters in length against 260 millimeters of the left bone. Table V shows the reduction in weight of scapula and clavicle to be about fifty per cent. of the weights of the sound bones.

No. 1531, a male white of fifty-four years, some months after amputation through the middle of the right humerus, shows neither rarefaction nor reduction in dimensions of the bones of the mutilated limb.

No. 1456, a male white of about fifty years, shows amputation through the middle of right humerus and lower third of left. There is character-

TABLE V

Loss in Weight Expressed in Percentage of the Sound Side

	Skeleton No.	Time Since Operation	Scapular Loss	Clavicular Loss
Upperarm				
	1531	Some months	15	4
	468	Less than 3 years?	44	Right clavicle missing
	666	Less than 3 years?	43	42
	730	More than 3 years?	52	44
Forearm				
	1019	15 days	+10 (heavier!)	2
	593	Long standing	5	10
Loss in Weight Expressed in Percentage of the Longer Stump				
Both upper arms . .				
	1456	Long standing	26	35

istic rarefaction on both sides and some deformation of the right humeral head, but no difference between the two sides in scapular and clavicular dimensions.

GROWTH OF THE MUTILATED HUMERUS

Checking these examples against skeletons from cases of old infantile and spastic palsy we find them differing from the palsied in the irregular collapse, reduction in size and even disappearance of specific features, and, as will be obvious from our clinical cases, premature epiphyseal union in the mutilated arms of adolescents.

J. Sm., a negro boy, suffered amputation just above the right elbow when he was fourteen years old. Four and a half years later the humeral shaft was actually reduced in girth, while scapular length measured 152 millimeters against 162 millimeters on the sound side. Typical rarefaction of the right humerus is evident on the roentgenogram and premature union of the humeral and scapular epiphyses has occurred by comparison with the left side.

E. Sc., a white boy, suffered amputation through the lower third of the left humerus at twelve years. Three years later marked gracility of humeral shaft, deformity of humeral head and gracility of clavicle were all evident. Five years after the amputation there was precocious union of humeral and scapular epiphyses.

J. Sa., a white boy, suffered amputation through upper third of left humerus at fifteen years. No gracility in humeral shaft remnant nor deformity of humeral head had developed six weeks after operation.

The postamputation changes in these adolescents confirm the conclusion derived from the study of the skeletons of adults,—namely, that amputation above the elbow results in a disturbance of growth and of skeletal characteristics fundamentally different from those seen after amputation through lower extremity or forearm. The conical stump is not produced by growth of the humeral fragment, but by actual shrinkage which involves bone as well as soft tissues and moreover spreads to scapula and clavicle of the mutilated limb.

CONCLUSIONS

1. After amputations of both upper and lower extremities, the outstanding feature is a generalized osteoporosis in the bones of the mutilated limb, at first patchy but rapidly becoming uniform. It occurs especially near articular ends and muscular attachments and it involves the secondary trabeculae of the cancellous tissue but not the primary architectural features. After lower limb and forearm amputations, rarefaction is obvious in ten days and ceases to progress after three weeks from the date of amputation.

2. After amputations above the elbow, the osteoporosis continues to progress beyond the three-week limit but without destroying the architectural pattern at first. Within a few years there is actual reduction in

dimensions of humeral stump, scapula, and clavicle, not explicable on the basis of failure of growth, though precocious union of epiphyses occurs after amputation during or before adolescence.

3. These postamputation phenomena of the upper arm differ from the subsequent changes in infantile and spastic palsy in their erratic distribution and the ultimate disorganization of architecture.

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GEOMETRICAL ANALYSIS OF SCOLIOTIC SPINES

BY CHARLES J. SUTRO, M.D., AND MAURICE M. POMERANZ, M.D.,
NEW YORK, N. Y.

Hospital for Joint Diseases, New York

Accurate determination of the curve of scoliotic spines by the Ferguson[1] method does not denote the relative compensation or decompensation of the chest to the vertical axis of the body. Although the spine may show many irregular curves, the chest may be either compensated or decompensated. The correction of the curve does not always bring about a compensated appearance of the chest. Since the treatment of scoliotic curves is designed to produce a compensated appearance, our measurements should indicate the amount of compensation or decompensation of the chest to the true vertical axis. The latter may be denoted by a plumb line (incorporated in the Bucky frame) or a line parallel to the vertical border of the roentgen plate. We have found that the plumb line was always parallel to the vertical border of the x-ray plate.

The normal chest (Fig. 1) may be considered as a trapezoid with *D* and *C*, the most lateral points on the right and left ninth ribs, and *A* and *B*, points similarly located on the right and left second ribs. Lines connecting these four points, *AB*, *BC*, *CD*, and *DA* form a trapezoid. The bases *AB* and *CD* are divided into equal halves (Fig. 1) by the vertical axis *XZ*, which corresponds to a plumb line through the middle of the sacrum. A line drawn from the outermost point on the second right rib, *A*, to a similar point on the right ninth rib, *D*, when intersected by a line parallel to the normal spine (that is, parallel to the plumb line), drawn at point *A*, forms the right axillary angle (angle *R1*). The right axillary angle (*R1*) equals the left axillary angle (*L1*), in the normal. Similarly, a line drawn from the outermost point on the second rib (*A*) to

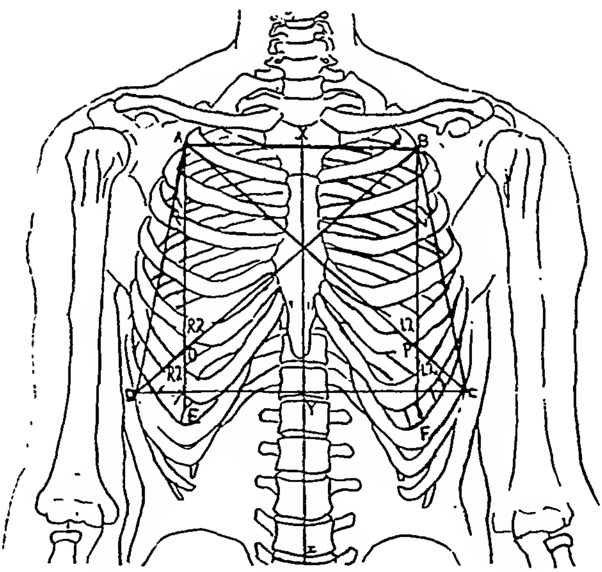

FIG. 1

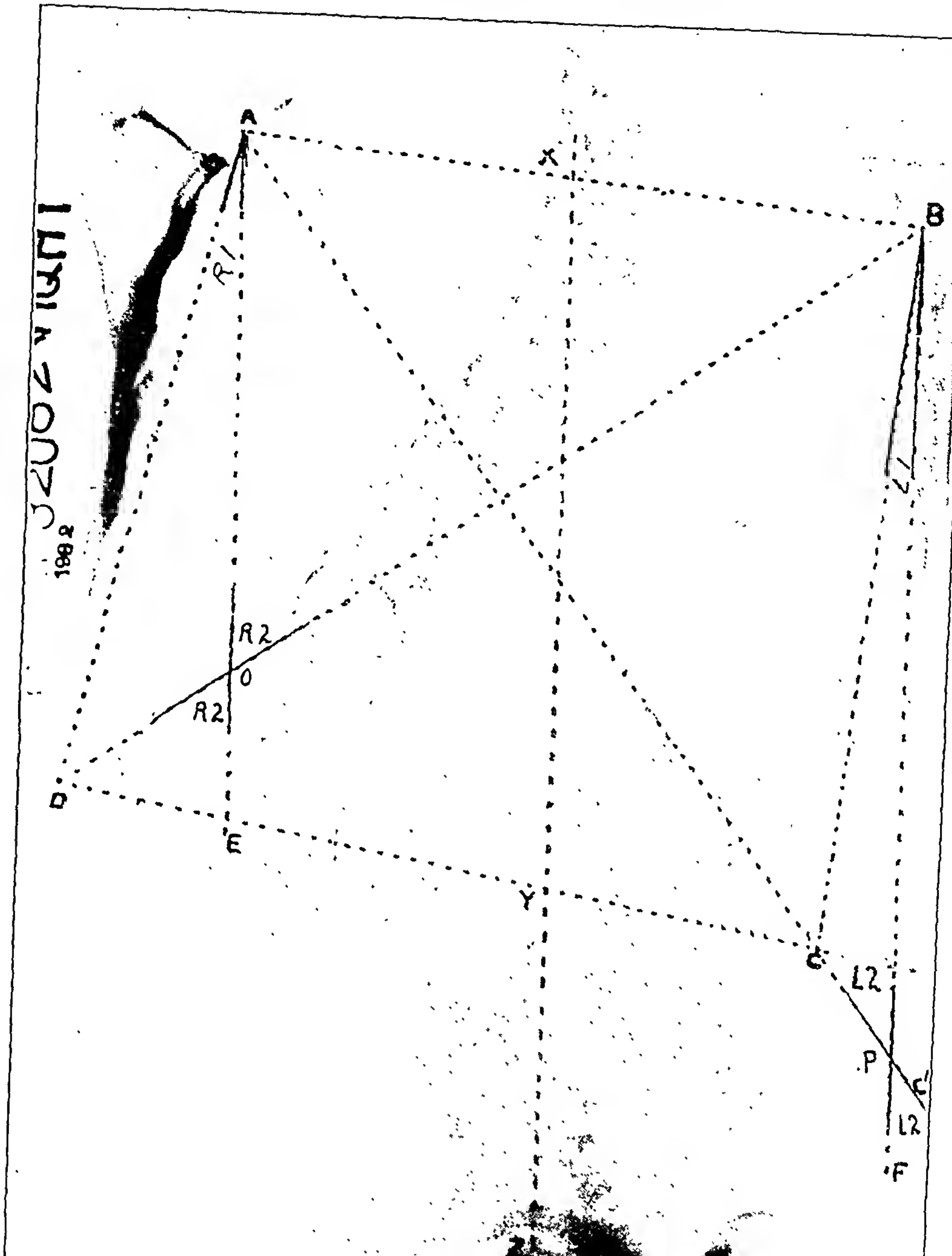

FIG. 2

the outermost point on the opposite ninth rib (*C*) will form the left diagonal angle (*L2*), when intersected by a line parallel to the plumb line, drawn at point *B*. The right diagonal angle, *R2*, equals the left diagonal angle *L2*, in normal cases.

Roentgenograms of many scoliotic spines, when measured by this method, show irregular geometrical figures with unequal axillary and diagonal angles. It is important to note that the normal variation in the anatomical size and shape of ribs does not allow of exact comparisons of different cases, the results being for each individual case.

The technique must be standardized. We used a Bucky *diaphragm*,

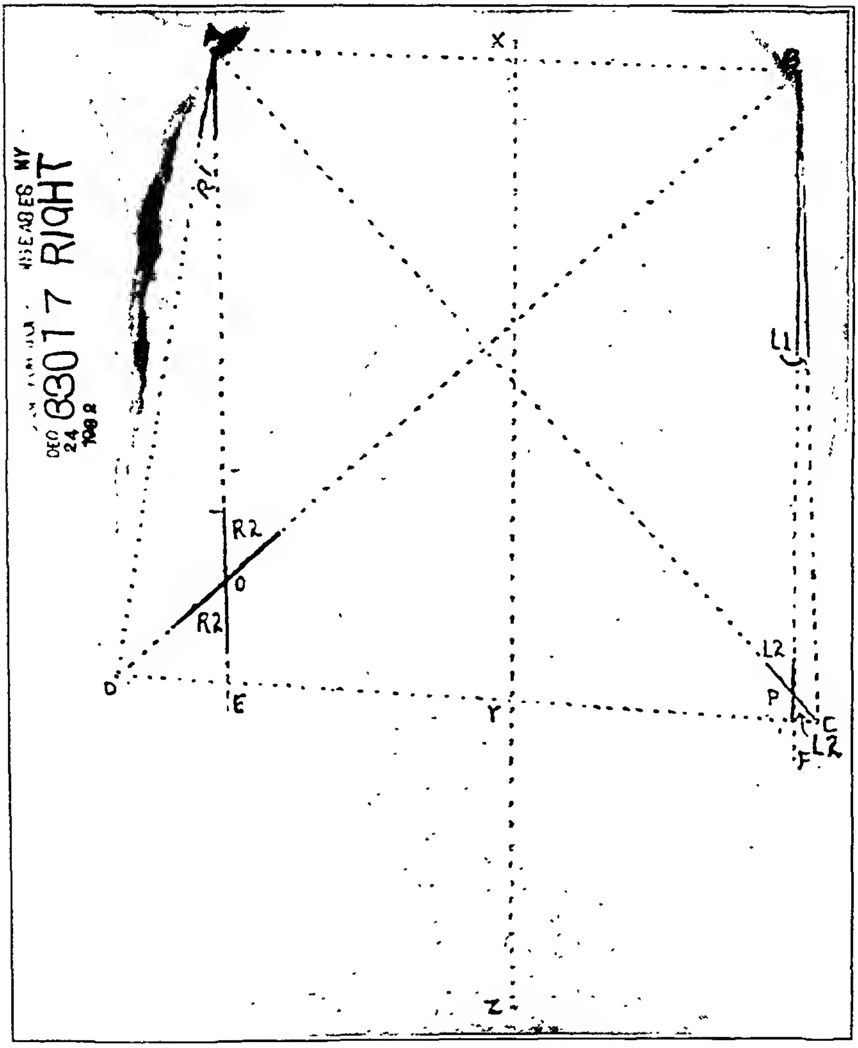

Fig. 3

fixed tube stand, and a target-plate distance of twenty-eight inches in our cases. The patients were examined roentgenographically in the standing position. In cases with a marked tilt of the pelvis, correction should be attempted. Considering the trapezoid as the geometrical outline in a normal chest, any deviation from that shape usually signifies changes in the spinal curvature.

Kleinberg[2] has confirmed the observation in cadavera that pressure on the chest produces abnormal curves in the spinal column. Thus, an abnormal spine when corrected should tend to produce a trapezoid figure. The degree of improvement can be determined by the angles aforementioned. When the right diagonal and right axillary angles equal the left diagonal and the left axillary angles respectively, and when the base lines

of the trapezoid are equally bisected by the vertical axis line, then correction may be said to be perfect. It is important to note that all angles need not be measured, for the measurement of angles *R1* and *L1*, or *R2* and *L2*, is sufficient for comparison, or the measurements of the intersected base lines, *AX*, *XB* (Fig. 1), may similarly show progressive alteration of the contour of the chest.

Case T. P., No. 40023 from Dr. Kleinberg's Service, is presented. Correction was attained by the application of a plaster-of-Paris jacket, followed at a later date by a unilateral spine fusion. The roentgenograms prior to the operation (Fig. 2) show a right axillary angle, *DAE* (called *R1*), of fifteen degrees, and a left axillary angle, *CBF* (called *L1*), of four degrees. The right diagonal angle, *DOE* (*R2*), measures fifty-eight degrees, and the left diagonal angle, *FPC′* (*L2*), thirty-two degrees. After operative intervention (Fig. 3) the right axillary angle (*R1*) measures five degrees; the left (*L1*), two degrees. Both diagonal angles (*R2* and *L2*) are forty-five degrees. The angle called *L2* equals angle *APB*. These figures show clearly that the correction has been almost perfect, for the lines drawn on the roentgenogram show a trapezoid almost normal in configuration.

The base lines *AB* and *DC* show the following measurements when intersected by *XZ*, the vertical axis (Figs. 2 and 3):

Line	*Prior to correction*	*After correction*
AX	4½ inches	4⅞ inches
XB	4⅞ inches	4⅞ inches
DY	6⅞ inches	6¼ inches
YC	4⅞ inches	5¼ inches

The upper base line (Fig. 3) in the trapezoid of the corrected spine is bisected equally, while the lower one shows slight inequality as compared to the trapezoid of the uncorrected spine.

SUMMARY

A method is proposed, whereby the amount of compensation or decompensation of a scoliotic spine can be accurately measured by comparing the geometrical figures formed by lines drawn from the second to the ninth ribs on both sides. The normal outline of the chest is designated as a trapezoid and abnormal chests in scoliotics show geometrical variations from that outline. The correction of a scoliotic curve should tend to produce a geometrical outline of the chest, approximately of trapezoid type.

We thank Dr. S. Kleinberg and Dr. S. A. Jacobson for helpful suggestions and Dr. I. B. Horwitz for the drawings.

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TREATMENT OF RHEUMATOID ARTHRITIS WITH HYPERTHERMIA PRODUCED BY A HIGH-FREQUENCY CURRENT

BY EDITH E. NICHOLLS, M.D., K. G. HANSSON, M.D., AND
WENDELL J. STAINSBY, M.D., NEW YORK, N. Y.

From the New York Hospital and the Department of Medicine of Cornell University Medical College, New York

Several investigators have published data concerning the value of hyperthermia produced by a high-frequency current in patients with paresis, and, recently, Bishop, Horton and Warren [1] and Kohn and Warren [2] have reported beneficial results from this procedure in cases of rheumatoid arthritis. It was the impression of these experimenters that, in the administration of this treatment, pain and swelling of the joints were lessened, and greater motility of the limbs was obtained. During the past nine months we have employed this method of therapy thirty-seven times on twelve selected patients with rheumatoid arthritis, and in the present paper we report the results of our study.

Considerable care was taken to apply the treatment only to patients whose physical status was good except for the arthritic condition, and whose joint disease was not sufficiently advanced to preclude hope of recovery. Nine of the twelve patients were ambulatory and presented the typical picture of rheumatoid arthritis, including fusiform swelling of the fingers. In these patients ankylosis and deformities other than swelling were entirely absent. Such changes in the joint structure as may be detected by x-rays were either slight or non-existent. In two other patients studied, the disease was somewhat more advanced; they were partially confined to bed and showed evidence, by x-ray, of moderate changes in one joint or more. The remaining case of the series was one of rheumatoid arthritis primarily involving the spinal column.

A brief record of the patients studied is presented in Table I. The average age in this group was thirty-nine and six-tenths years, the youngest being twenty, the oldest, fifty-six. The duration of the disease prior to treatment varied from one to ten years, with an average of three and nine-tenths years.

METHODS

Apparatus

A high-frequency generator was used,—one especially constructed to withstand long continued operation under a heavy load, and capable of delivering 3500 to 5000 milliamperes for at least one hour and a half. A large, perforated, tinfoil electrode covered the back of the patient while similar ones were placed over the chest and abdomen.

TABLE I

PATIENTS TREATED WITH HYPERTHERMIA

Patient	Sex	Age	Duration of Arthritis	Agglutination Titer	C. S. I.	Number of Treatments	Complications of Treatment
1	M	49	2 years	1:320	1.4	1	Herpes of mouth.
2	F	56	6 years	1:2560	1.15	1	Herpes of mouth and retina.
3	F	35	6 years	1:160	0.9	2	Herpes of mouth.
4	M	20	1 year	negative	1.28	2	
5	F	41	10 years	1:1280	1.48	2	Burns on breast.
6	F	38	1½ years	1:640	0.62	3	
7	F	51	1 year	1:640	1.1	3	
8	M	36	4 years	negative	1.0	4	Burn on abdomen.
9	M	49	3½ years	1:640	0.6	4	
10	F	41	3 years	1:2560	0.5	5	Herpes of mouth.
11	F	30	4 years	1:2560	0.8	5	
12	M	29	5 years	1:2560	0.78	5	

Agglutination tests were carried out with "typical strain" streptococci as previously reported[3,4].
C. S. I. refers to the *Corrected Sedimentation Index* taken immediately before treatment.

Preparation of Patient

On the day of the treatment, the patient was given a light breakfast and was encouraged to take as much fluid as possible. The bowels and bladder were emptied. A hypodermic injection of 0.015 grams of morphine was given immediately prior to applying the current. The lips were covered with vaselin to prevent herpes.

Treatment

For convenience, each treatment usually began at ten o'clock in the morning, so that the whole procedure would be completed by late after-

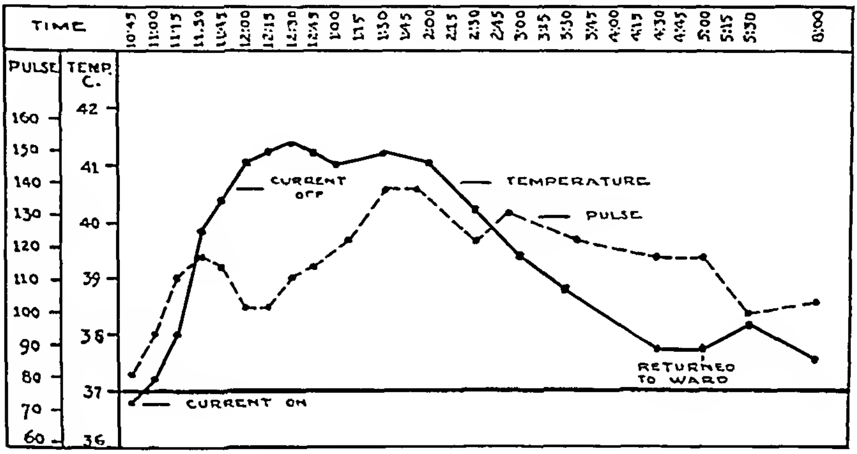

FIG. 1

Mouth temperature and pulse record of a patient during one of the treatments.

noon. The patient was placed on an ordinary hospital bed with rubber sheets covering the mattress. A bridge of incandescent lamps, called a "baker", was placed over the subject. Rubber sheets covered the bridge and the bed. Several heavy blankets were placed over the "baker" and around the neck of the patient, in order to prevent escape of heat. By this means, the individual was not encumbered by any weight on the body and was able to change position at will throughout the treatment.

The high-frequency current and the "baker" at low heat were turned on simultaneously. The maximum current, 3000 to 5000 milliamperes, was reached in about five minutes, and maintained until the desired temperature was obtained. The current was usually turned off when the patient's temperature by mouth reached between 40 and 40.5 degrees, centigrade, which took place in about one hour or one hour and a half. This degree of temperature was considered the highest that could be given with safety, as the fever curve tended to become slightly further elevated for a short period of time after the current had been turned off. In a few instances, the treatment had to be carried out at a slightly lower temperature because of the extreme restlessness of the patient. During

the period of high fever; an electric blower maintained a circulation of warm air around the patient which considerably lessened the discomfort.

As soon as the desired temperature was reached, the high-frequency machine was disconnected and the electrodes were removed. By means of the "baker", the temperature of the patient was maintained at a high level for several hours, after which it was gradually permitted to return to normal. An elevated temperature was usually sustained for a period of about five hours. When it became normal, the blankets and "baker" were removed, and the patient, returning to the ward, was given the ordinary nursing care required for the safety and comfort of any fever patient.

Both a doctor and a nurse were in constant attendance throughout the treatment. By means of a potentiometer, the rectal temperature was registered continuously on a chart. Mouth temperature, pulse, and respiration were recorded by the nurse at fifteen-minute intervals. Face and forehead were sponged constantly with cold water, and the patient was allowed to drink small quantities of warm water. Occasionally, 0.03 grams of phenobarbital was given during the treatment, to control the restlessness.

In Figure 1 is shown the temperature and pulse record of a patient during a hyperthermia treatment. Corresponding records of the other patients are quite similar. In each case, the curve of the pulse rate closely paralleled that of the temperature.

The maximum temperature by mouth in any of the treatments was 41.4 degrees centigrade, the lowest was 39 degrees, with an average for the thirty-seven treatments of 40.2 degrees, centigrade.

RESULTS OF TREATMENT

Altogether thirty-seven hyperthermia treatments were given to twelve patients, and the number per patient varied from one to five, as indicated in Table I. Intervals of one week were usually permitted between treatments.

Observations During Treatment

In spite of a generous use of sedatives, all of the patients suffered considerable discomfort from the high fever induced, and it was often difficult to persuade them to repeat the experience. During six of the treatments the patient became irrational at the height of the fever.

While the current was being applied, the skin became flushed and the body was covered with a profuse perspiration; greater mobility of the joints and freedom from pain were reported by all patients.

Observations After Treatment

With the first four treatments, the patients developed herpes around the mouth and nose. Prior to succeeding treatments vaselin was smeared generously over the lower part of the face, and the incidence of herpes was

greatly diminished. One patient developed herpes of the retina which, however, gradually but completely disappeared. In two instances, nausea and vomiting set in immediately following the treatment. This continued for twenty-four hours in one case, but lasted a few hours only in the other. In a number of instances, a mild, first-degree skin burn was noted, at the site of contact of the electrodes with the body. This usually cleared up in about twenty-four to forty-eight hours. In two instances more severe burns occurred, with ulceration and sloughing of tissue. In one case the breasts were involved; in the other, the abdomen. These burns required approximately three weeks to heal completely. There were no deaths, no complications other than those reported, and no apparent permanent injuries.

Of considerable interest, of course, is the effect on the arthritic process. In almost every instance, the stiffness and pain, as well as the swelling, were definitely lessened as a result of the treatment, but these changes were never of a permanent or prolonged nature. Usually in forty-eight hours, but occasionally not until after two weeks, the joints returned to a condition approximating that before the administration of hyperthermia. The temporary decrease in swelling, resulting in greater freedom of motion of the joints, is probably due to dehydration of the body, which occurs with this form of therapy.

Also of interest is the patient's impression concerning the treatment. Because of the dramatic nature of the procedure, it was thought that the psychological effect would be marked, but in this, too, we were disappointed. The follow-up of the patients after discharge from the hospital indicated that only three of them felt that they had derived any lasting benefit from the treatment. In each of the instances where improvement was reported, examination of the joint swelling and mobility failed to confirm the patient's impression.

Ten of the twelve patients were studied by the *erythrocytic sedimentation test*. The rate of sedimentation of the red blood cells appears to bear a definite relationship to the severity of the arthritic process, although the test is not specific for rheumatoid arthritis[5]. Patients with severe arthritis have a higher sedimentation rate than those with mild arthritis, while those showing improvement, give progressively decreasing sedimentation rates. The sedimentation test used in this study was that recommended by Rourke and Ernstene[6], and the figure indicating the sedimentation rate is known as the *corrected sedimentation index*. The test was made immediately before hyperthermic treatments were begun and was repeated at intervals throughout the observation periods. The average corrected sedimentation index of the ten patients before treatment was 0.9, while at the end of the observation period it was 0.92. The average length of time between the final treatment and the follow-up sedimentation test was thirty-seven days. This laboratory test confirms the clinical impression that little or no lasting improvement resulted from the hyperthermic treatments.

SUMMARY AND DISCUSSION

Twelve patients with rheumatoid arthritis were treated with hyperthermia produced by a high-frequency current. The number of treatments for each patient varied from one to five. Although considerable care was exercised to lessen the discomfort arising from the treatment, each patient considered the experience a trying ordeal. No serious complications resulted from the treatment. While, in most instances, temporary relief of symptoms was noted, there was no evidence that any lasting benefit was derived from this form of therapy. The results were so discouraging that we felt we were not justified in continuing this form of treatment in rheumatoid arthritis.

CONCLUSIONS

No lasting improvement was demonstrated in our series of cases of rheumatoid arthritis treated by hyperthermia produced by a high-frequency current.

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A NEW TREATMENT OF INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR AND LEGG-CALVÉ-PERTHES DISEASE. TECHNIQUE

BY E. J. BOZSAN, M.D., F.A.C.S., NEW YORK, N. Y.

Division of Skeletal Surgery, Morrisania City Hospital, New York

In a preliminary report [1] the author has recommended the drilling of longitudinal channels as a curative measure for intracapsular fractures of the neck of the femur and various manifestations of the pathological process generally known as Legg-Calvé-Perthes disease. Because of the favorable results obtained in a larger series of cases (to be presented in the near future, after thorough follow-up) the technique of the procedure is here presented, as it has been developed during the last three years, in thirty cases of fracture of the neck of the femur and in ten cases of various forms of Legg-Calvé-Perthes disease, including in the latter cases of slipping of the upper femoral epiphysis.

In cases where separation has occurred in the epiphyseal plate in children and young adolescents, and in cases of intracapsular fracture of the femoral neck in adults, an accurate reduction of the separated parts should precede the drilling. This may be done as a separate manoeuver in closed reduction, or, combined with the drilling, done at the same time and through the same operative approach.

CLOSED REDUCTION OF FRACTURES OF THE NECK OF THE FEMUR WITH SUBSEQUENT DRILLING

It is difficult to improve upon the Whitman [2] method of reduction and retention and more difficult to find the reason why this improvement should be sought in the great majority of cases, for all or most of the working principle of that method cannot and perhaps ought not to be altered. With this in mind the author presents no particular claim to originality for the manipulations by which he seeks to comply with the requirements of the Whitman principle. They are submitted only as a simple and convenient way in which to attain the same results as may be obtained by the original method or many of its numerous modifications (Ruth[3], Murray[4], Leadbetter [5]).

In devising these manipulations the author was guided by the knowledge that, in cases of complete fracture without impaction, the distal fragment points ventralward and stands almost vertical in the recumbent patient. This was definitely established,—first, by findings at open reduction; second, by sounding with the injecting needle while administering a local anaesthetic to patients with hip fractures; third, by lateral roentgenograms of the femoral head and neck, the technique for which has been perfected recently both here[6,7] and abroad[8,9]. The recognition of this fact suggested that the reduction might be more promptly

effected if the neck were pulled away in the lateral direction from the head and acetabulum. When the fragments are separated in this manner, the neck fragment will not impinge anteriorly on the head during the manoeuver of internal rotation of the limb, but may freely move down to meet the fracture surface of the central fragment.

The reduction, as illustrated by Figures 1, 2, 3, and 4, is accomplished as follows:

1. The patient is placed on the fracture table with both limbs straight.

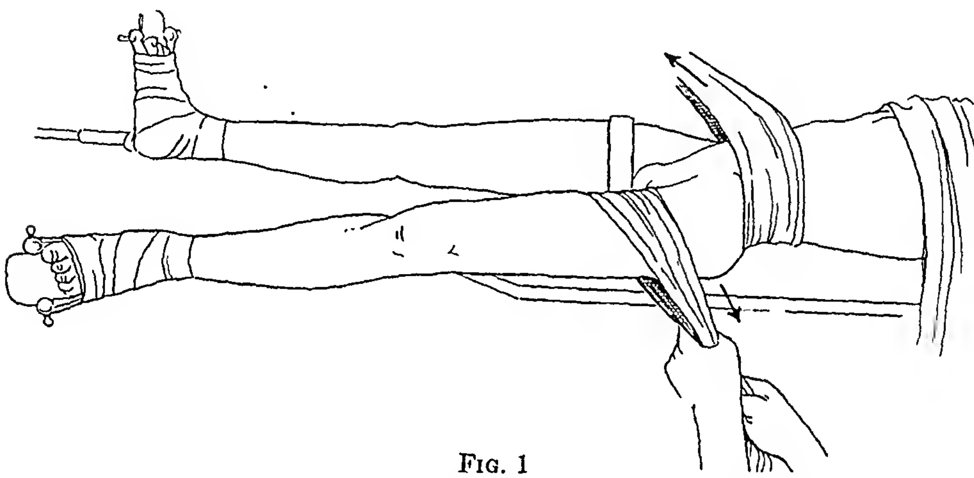

FIG. 1

Lateral traction on the femur and countertraction on the pelvis, with both extremities straight.

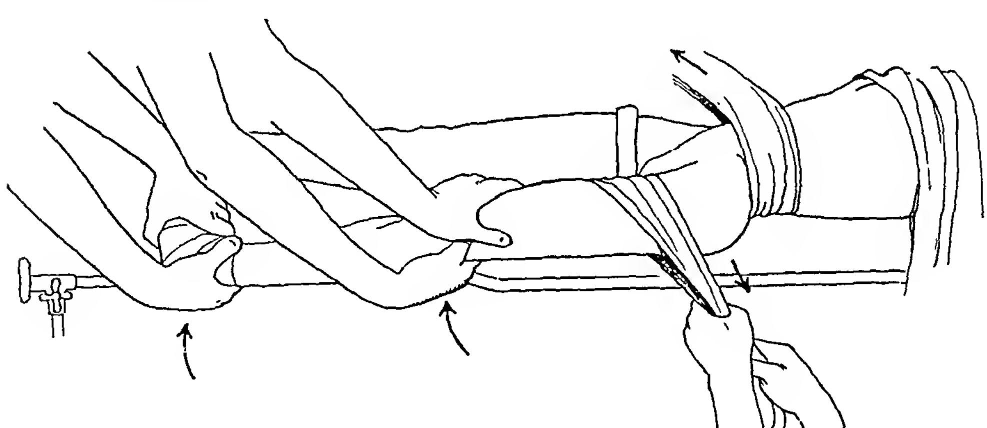

FIG. 2

Inversion of the whole limb while lateral traction at the hip is at its maximum.

2. Both feet are bandaged to the traction apparatus in whatever position they assumed spontaneously.
3. A large swathe is passed around the crest of the ilium of the affected limb, and a small swathe around the affected thigh high in the inguinal fold.
4. Without altering the straight position of the affected limb, vigorous lateral traction is exercised by the small swathe, countertraction by the large swathe (Fig. 1).

5. At the peak of the lateral traction the whole affected limb is rotated maximally and internally (Fig. 2).

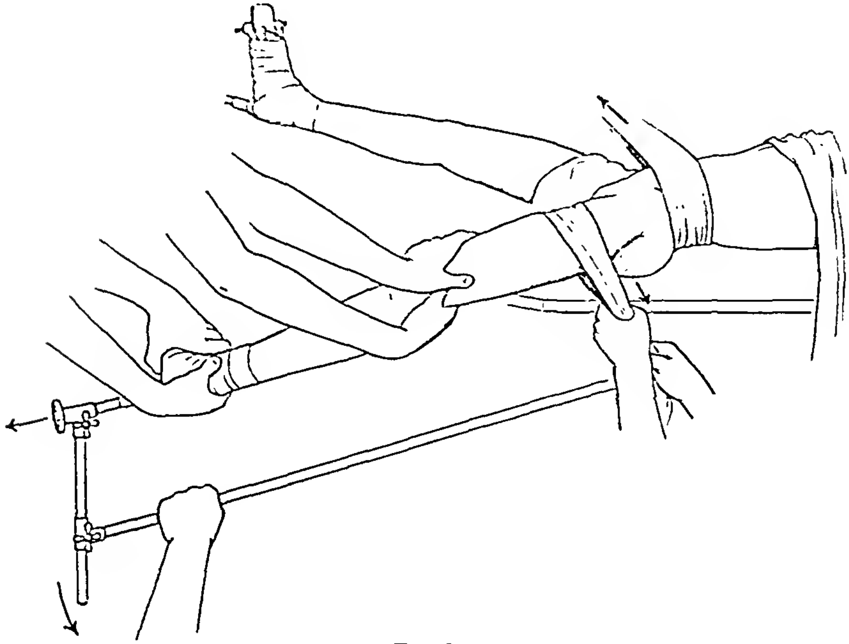

Fig. 3

Longitudinal traction, abduction, and slight hyperextension of the affected limb, combined with lateral traction.

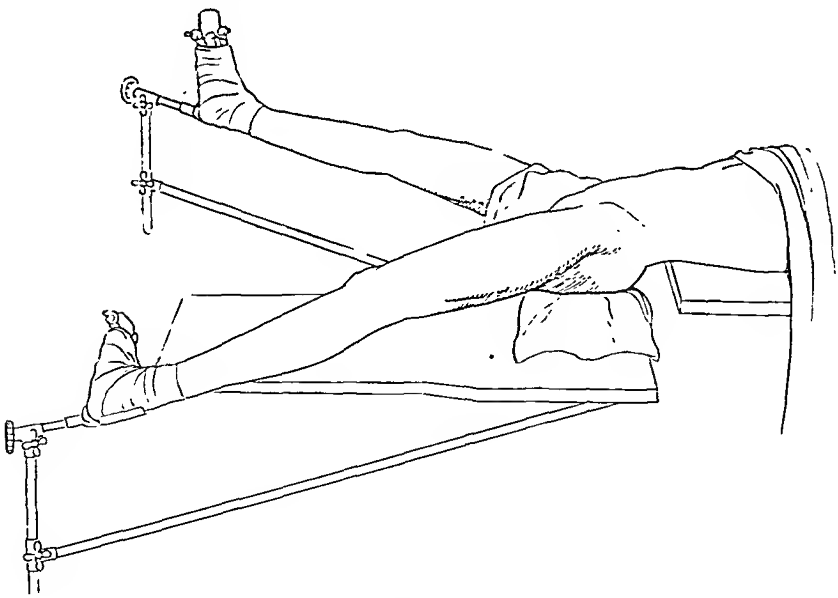

Fig 4

Reduction accomplished with both legs in abduction, the affected limb maximally inverted. The retrotrochanteric hollow is well reestablished.

6. While the lateral traction is continued, the affected limb is abducted, slightly hyperextended, and longitudinal traction is applied (Fig. 3).

A rotating upward lift with the small swathe may well assist the manoeuver of internal rotation which should not meet with any resistance; if resistance is encountered, lateral traction must be increased. When internal rotation is completed, the limb should not snap back into its former position.

The measure of abduction is best determined by roentgenograms. If these are not available, considerable to maximum abduction is advised. There need be but little longitudinal traction, serving to prevent upward slipping of the neck during abduction rather than to pull the neck down.

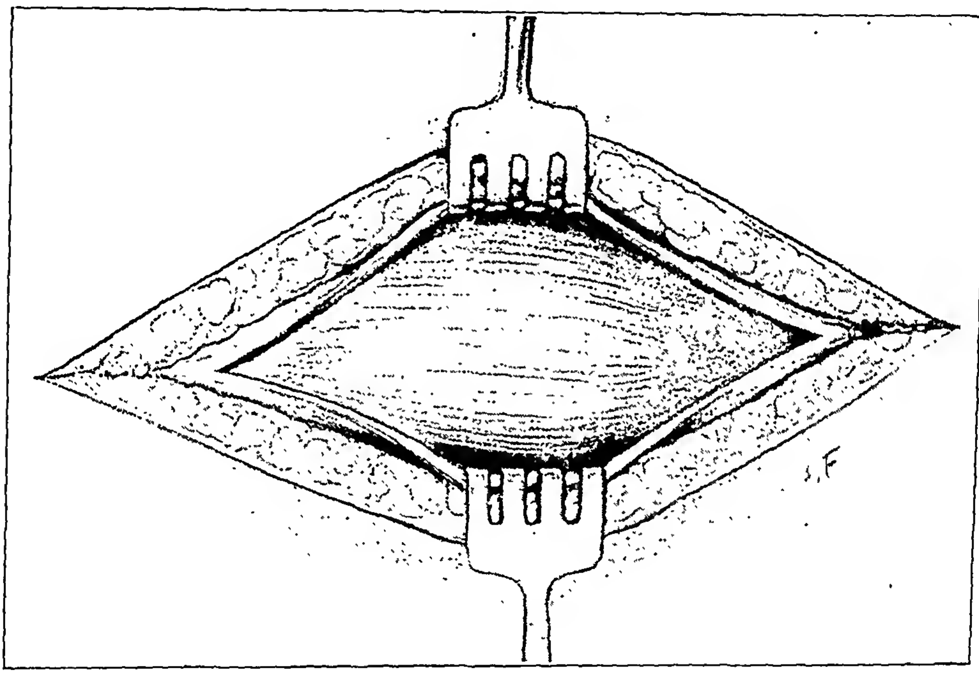

FIG. 5

Incision of the fascia lata, exposure of the vastus lateralis and lowest promontory of the greater trochanter.

In the absence of roentgenographic control, the accuracy of the reduction may be fairly judged by the appearance of the affected hip:

1. The retrotrochanteric hollow, formerly filled out to bulging convexity, has now reappeared.
2. The greater trochanter stands out prominently, well forward, and but little below the anterior superior spine.
3. A high degree of symmetry is present if the unaffected limb is brought into identical position with the affected limb, internal rotation included (Fig. 4).

These external landmarks, quite apparent to the eye accustomed to the picture, need not, however, be relied upon. During subsequent exposure of the region and drilling of the femoral neck and head, as

described in the following pages, the palpating finger obtains objective evidence of the correctness of the reduction.

ONE-STAGE OPEN REDUCTION WITH SUBSEQUENT DRILLING

The patient is placed in a somewhat different position on the fracture table,—namely, the affected extremity is brought into a slight degree of abduction at the outset. This is necessary because, in the straight position of the extremity, the tendon of the gluteus maximus is at times so tightly stretched across the greater trochanter that it is difficult for the

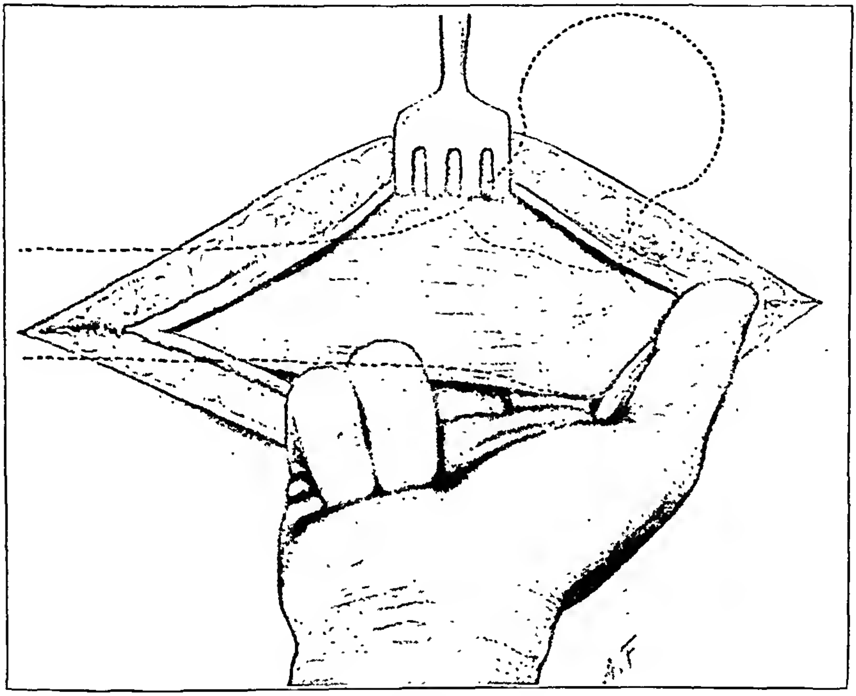

FIG. 6
Palpation of the posterior aspect of the neck and hip joint.

palpating finger to slip between the two. This situation is often indicated on the roentgenograms by a straight band of shadow bisecting the greater trochanter longitudinally.

Without any preliminary reduction, an incision is made over the affected trochanter, as indicated in Figure 5, through the skin and fascia lata, exposing the vastus lateralis and the lowest promontory of the greater trochanter. The skin incision should be placed well toward the rear, allowing room for instruments to be applied later at various angles to the horizontal. The incision in the fascia should avoid the muscle body of the tensor fasciae femoris.

Upon the smooth surface of the shiny aponeurosis of the vastus lateralis, one or two fingers are slipped around the posterior circumference of the femur and palpate without essential obstacle the whole posterior

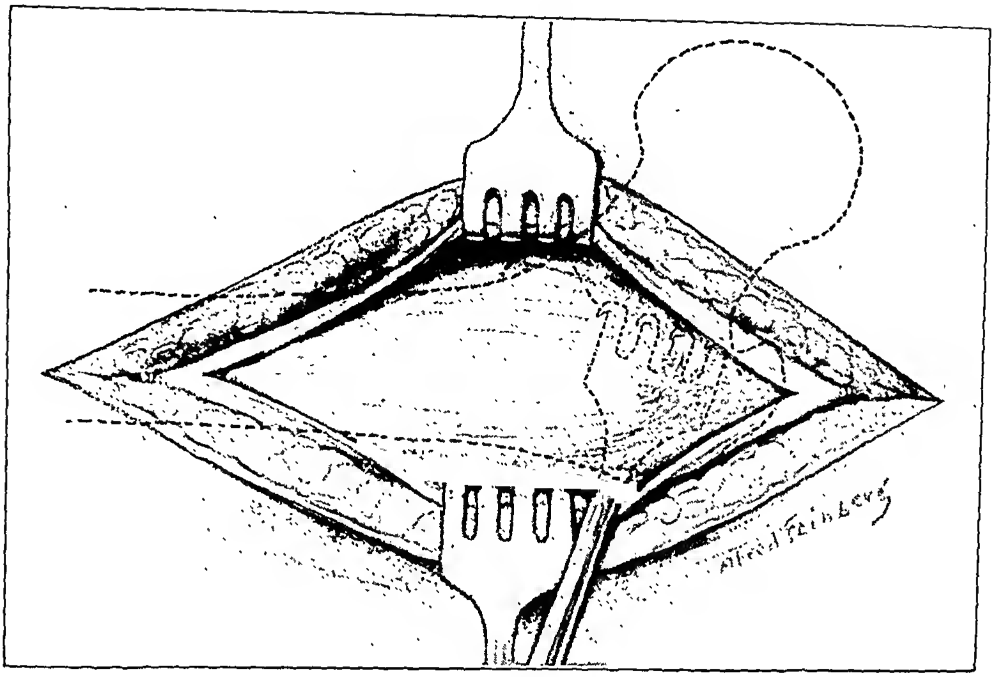

FIG. 7

The retractor is inserted into the mass of the greater trochanter at the intertrochanteric line, thereby exerting direct traction on the neck.

aspect of the hip joint (Fig. 6). At times the fingers are caught in the blind sack of the trochanteric bursa, but in general it is difficult to miss the proper connective-tissue spaces that afford easy access to the side of the pelvis, the acetabulum, and tuber ischii.

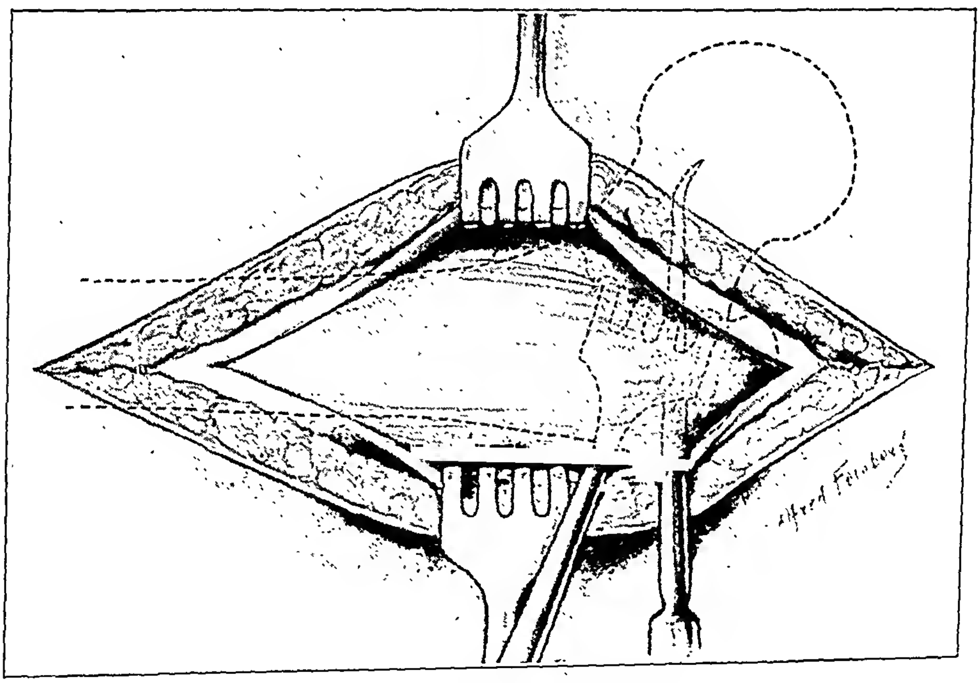

FIG. 8

Both the sharp retractor and the pointed lever are shown in position, the latter thrust through the capsule and lifting the head.

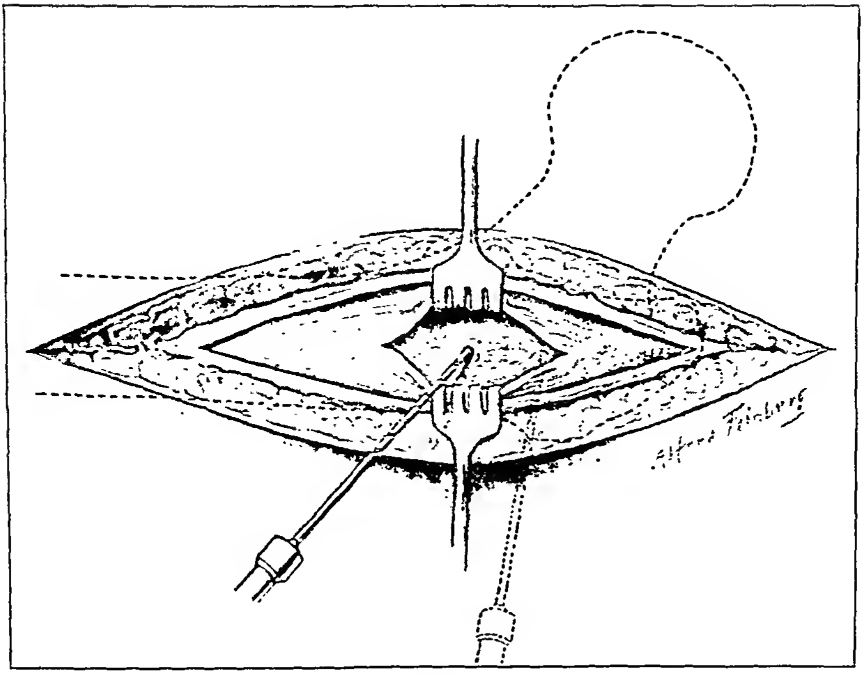

Fig. 9
Drill penetrating at different angles.

The palpatory findings of an unreduced neck fracture are fairly typical:

1. The greater trochanter is rotated outward and its free lateral surface looks downward into the hollow of the gluteus maximus.
2. The whole of its mass and the intertrochanteric line is close to the pelvis and acetabulum.
3. The lesser trochanter, the most important structure to locate as it indicates the degree of external rotation, is found lying anteriorly and medially, so that the palpating finger has to encircle with almost its whole length the shaft of the femur before reaching it. It may be easily located by following the intertrochanteric line, and may be identified by its smooth round prominence.
4. At times a tear is present in the capsule, and through this the smooth surface of the neck is palpable.
5. On the anterior surface of the hip joint, palpation reveals at times a striking angulation between the rim of the acetabulum and the neck, the latter being almost in a vertical position.

The reduction, which rightfully should be called semi-open reduction as the fracture site itself is not exposed, is effected by a sharp retractor or single hook. This is inserted into the mass of the greater trochanter at the intertrochanteric line and the neck is then pulled away from the acetabulum by straight lateral pull (Fig. 7). When this lateral pull

reaches its maximum, an assistant rotates the whole limb into maximum inversion. From this point on, the reduction is completed in the same manner as that employed in the closed method.

The reduction completed, the changes in palpatory findings will be unmistakable and also fairly typical:

1. The lesser trochanter has moved downward and outward, pointing almost directly downward, and is now within easy reach.
2. The greater trochanter is lifted out of the hollow of the gluteus maximus. Its free lateral surface is now fairly vertical and its tip is near the upper circumference of the acetabulum.
3. The intertrochanteric crest extends far out and away from the side of the pelvis, and the neck, now horizontal, is palpable through the capsule, pointing toward the center of the acetabulum.
4. The quadratus femoris, like a string across a bow, is stretched taut at the lower contour of the neck.
5. On the anterior surface, whatever angulation may have been present has disappeared.

It is clear that all our manoeuvering at reduction does not influence directly the position of the head, and an element of chance must remain, due mostly to the sagging down of the head which often mars the completeness of the reduction. To overcome this, an instrument has been constructed (Fig. 11) which is introduced under the neck (Fig. 8), and its point, penetrating the joint capsule, lifts the head upward while the neck is pulled away. The neck, when released, is expected to arrest the head in this more favorable position. There has been a noticeable improvement in the position of the fragments when this instrument has been used. It should, however, be used with care, and only in case of need.

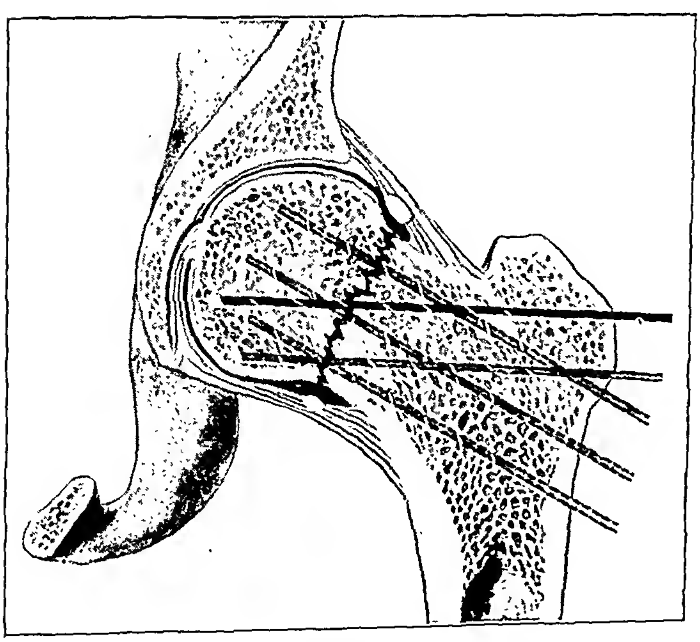

Fig. 10

Diagram showing distribution of drill channels in the case of a fractured neck of the femur.

The reduction is followed by drilling (Fig. 9). So far, the author has used a hand-driven apparatus, affording good palpation when penetrating from one fragment into the other, and transmitting a fairly well differentiated sensation of the quality of bone penetrated. The drill itself is seven sixty-fourths of an inch wide

and five and seven-eighths inches long, with two grooves and a spicule at its tip. This spicule engages well, even into the cortical bone, and prevents slipping.

Just below the lowest palpable promontory of the greater trochanter, about where the cortical structure of the shaft begins, a small incision is made in the vastus lateralis to admit the drill. The drill may be thrust through the muscle, but then care must be taken not to allow the drill to wind soft tissue, especially the aponeurosis, around itself.

The direction and depth of the drill channels, diagrammatically shown in Figure 10, are estimated by palpation. Since the first few cases, protractors have not been used to calculate the angle. It is fairly difficult to go astray. Two rules, however, should be observed,—one should not go below the level of the lesser trochanter or above the middle of the greater trochanter. In the cases treated thus far, the number of drill holes varied between five and nine.

It was observed that, if the drill was withdrawn without being unwound, the grooves of the drill contained various amounts of bone chips. An attempt was made to deposit these chips between the fracture surfaces by withdrawing the drill to the estimated distance and then unwinding it.

After operation is completed, a plaster-of-Paris spica is applied. The spica is left in position for twelve weeks in cases of hip fracture in adults and eight weeks in cases of epiphyseal separation in children. After these respective periods, the spica is bivalved. The patients then remain on the posterior shell until, by gradual and careful active exercises, they are able to perform straight leg raising out of the shell. This

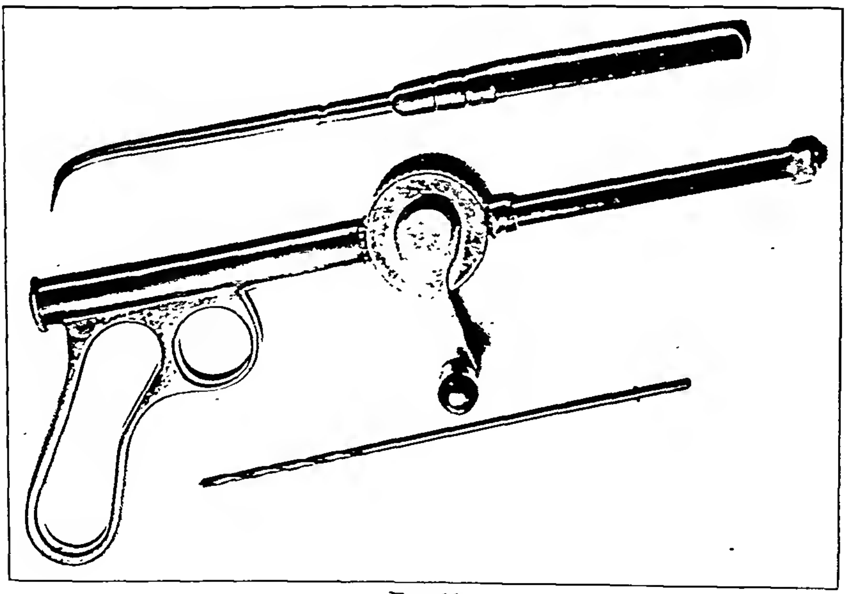

FIG. 11
Instruments used in operative procedure.

is usually accomplished in two to four weeks. The author is convinced of the correctness of the dictum of Scudder [10] that, if union occurs at all, it does so in eight weeks, but is very frail. Therefore, at present, the author does not favor roentgenographic examination or measuring for and trial of braces, with the unavoidable, unskilled handling, until straight leg raising indicates that union is firm enough to bear at least the weight of the extended limb. The length of time until the union is resistant enough to bear the weight of the whole body varies widely and, again in conformity with Scudder, the author is unwilling to believe that less than ten months to a year is sufficient, and every effort is made to prevent weight-bearing until such time has elapsed, in order to avoid shortening or total collapse of the neck.

The anaesthetic of choice is avertin in small doses. The anaesthesia need not be too deep, rather supported by gas-oxygen. This method has been found very satisfactory as it gives ample time for the application of the plaster and necessitates no hurry whatsoever on account of the anaesthetic. Spinal anaesthesia may be used, of course, but the necessary lowering of the head and raising of the pelvis is somewhat disturbing. Local anaesthesia, if accurately administered, is applicable, and was used in five cases, but it is not recommended because it constitutes an additional strain on the patient without any important advantage.

The operation may be performed at any time after the accident. It is advisable to wait four or five days during which the condition of the patient may improve, transient incontinence of the bladder may pass, or general consequences of the accident—such as mental disturbances, fat embolism, pulmonary complications—may develop without being aggravated by the additional insult of the operation, or accounted for by it. If the patient has been treated previously by some other method, and by chance non-union has resulted, the operation is recommended while there is still some portion of the neck unabsorbed, and while the head and neck may still be expected to be brought into contact and retained so. To determine the presence and size of the distal neck stump, roentgenograms with the limb in extreme internal rotation should be taken. In this way, surprisingly long neck stumps are sometimes discovered. If absorption of the fragments has progressed too far, and the distal fragment slips stubbornly upward, the drilling should be performed subsequent to a Brackett [11] operation through the same approach.

PROCEDURE IN LEGG-CALVÉ-PERTHES DISEASE

In cases of Legg-Calvé-Perthes disease, without separation between neck and head, the operation consists of drilling of the neck and head, with or without exposure of the greater trochanter. In these cases it is essential to penetrate the focus indicated by the roentgenograms. A drilling into the neighborhood of the process will result in improvement, but direct attack should be attempted. The channels become visible in later roentgenograms and will prove the accuracy of the drilling. A

description of the performance of the drilling in the various manifestations of Legg-Calvé-Perthes disease would be beyond the scope of this article, as it must be determined in each case.

If separation has already occurred between the head and the neck, the procedure is identical with the treatment of intracapsular fractures in adults. Due to the smaller proportions of the parts, the single hook is more appropriate to exercise the lateral pull than the four-pronged retractor. While drilling the neck, the epiphyseal plate of the greater trochanter should be avoided. This may be located accurately by sounding with a surgical needle. An extensive longitudinal drill channel through this area might result in premature ossification. This is true also as regards the epiphyseal plate between the head and the neck, although this is only punctured. Not more than two or three channels are made, this number appearing to be sufficient.

DANGERS

The whole procedure is remarkably free from shock and hardly necessitates any hemostasis; yet there are potential dangers present that must be carefully guarded against.

Soft muscle bodies, especially that of the quadratus femoris, may be turned into pulp by the endeavor of too eagerly palpating fingers to find the lesser trochanter.

The trochanteric bursa, into which the palpating finger may find its way, is easily torn to shreds. This may be avoided if the palpation is begun at the level of the shaft and not at the trochanter. Should the bursa be badly traumatized, it may be excised without any difficulty or ensuing hemorrhage.

If the retractor is not firmly inserted into the bone mass at the intertrochanteric line, it may tear out a layer of bone and lacerate the muscles.

If the retractor is inserted too far proximally to the intertrochanteric line, it may injure the vessels in the intertrochanteric fossa.

The drill may penetrate into the surrounding soft parts. This may be easily avoided if one bears in mind that the anterior surface of the neck is a flat continuation of the plateau on the anterior surface of the greater trochanter, but its posterior surface is about at the level of the center of the greater trochanter. Channels that have gone astray may bring about ossification in the soft parts with resulting limitation of motion, sometimes a welcome development, but usually undesired.

Forceful sponging toward the side of the pelvis may molest the sciatic nerve.

Penetration into the acetabulum may be prevented by calculating from the roentgenograms the depth of the heads on both the affected and normal sides and by the definite sensation felt when the drill penetrates across the fracture line from the distal into the proximal fragment, the latter giving a wide enough margin of safety. Thus far there has been no evidence that such penetration into the acetabulum has occurred.

Soft parts, especially the aponeurosis of the vastus lateralis, may wind themselves around the drill, and considerable traumatization may ensue. This may be avoided by careful retraction.

CONTRA-INDICATIONS

While the open reduction and drilling hardly appear to be contra-indicated, the postoperative immobilization in a plaster spica might be objected to seriously in some cases, such as partial or total incontinence, marked degree of non-cooperation, extreme abundance or absence of subcutaneous fat, and nervous disorders. In these instances, any of the lately developed methods of retention [12, 13] may be used to satisfaction.

The Russell traction, with some additional contrivance to prevent external rotation, and rendered more stable by pull on an os-calcis pin or wire, seems a good substitute for the plaster spica. The Thomas splint might also serve well. These various substitutes for the Whitman spica, however, still have to prove themselves efficient. A detailed analysis of their respective merits would be beyond the scope of this article.

HISTOLOGICAL EXAMINATION OF BONE CHIPS

If the drill is withdrawn unwound, the grooves always contain sufficient chips of bone for microscopic examination. The author has observed an apparently constant relationship between the amount of bone gained and the existing pathological condition,—for example, a very small amount of bone is obtained when drilling in a case of early Legg-Calvé-Perthes disease, whereas a case shown by roentgenograms to be well advanced usually yields solid bone ribbons which fill the grooves of the drill accurately and, with the aid of a later roentgenogram, permit the allocation of certain sections of the bone ribbon to definite sections of the drill channel in the roentgenogram. The interpretation of the histological findings must carefully discount the possible traumatization of the material.

A detailed account of the results of these histological examinations cannot be given at this time. The writer wishes only to emphasize the usefulness of the histological examination of the material thus gained, especially in cases of Legg-Calvé-Perthes disease, in corroborating an early clinical diagnosis long before the full roentgenographic evidence has obviously demonstrated it, justifying the therapeutic interference before irreparable deformity has developed.

CLOSED OR OPEN REDUCTION OF FRACTURED NECK OF FEMUR

While the author considers the one-stage open reduction, with subsequent drilling, the procedure of choice, yet the method of closed reduction has been described for the following reasons:

1. Simple as the one-stage open reduction with subsequent drilling is, the closed reduction with subsequent drilling is still simpler

and brings the operation well within the reach of a greater number of surgeons.

2. There is the possibility of percutaneous drilling with smooth surface drills under roentgenographic control, in which case closed reduction is indicated.

The work reported was made possible by Dr. Edwin A. Spies, Surgeon-in-Charge, Division of Skeletal Surgery, and I wish here to express my sincere appreciation and thanks for the opportunity and help extended. I also wish to thank Dr. Thomas J. O'Kane and Dr. Thomas I. Brennan for their valuable support throughout the course of the work.

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MECHANICAL INSTABILITY OF THE SHOULDER JOINT IN RELATION TO PREVENTION AND TREATMENT OF PAINFUL SHOULDERS *

BY LLOYD T. BROWN, M.D., AND JOHN G. KUHNS, M.D.,
BOSTON, MASSACHUSETTS

The habitual position in which the shoulder is used influences the mechanical stability of the shoulder joint and often has a direct bearing upon the common disabilities in this region[1]. Slight injuries here often result in periods of prolonged discomfort, pain, and loss of function. Most of these disabilities are diagnosed as subdeltoid bursitis[2], acromial or subcoracoid bursitis, neuritis, and, occasionally, muscular strains [3] or tears, the latter usually of the supraspinatus tendon[4]. A study of the histories of patients suffering from these disabilities will show the same precipitating mechanism in most of them,—*i. e.*, a movement in abduction or external rotation at the shoulder joint, or an injury to the region of the joint, such as a fall with the arm in abduction and external or internal rotation [5, 6]. There are a small number of cases where there is no sudden onset, but where the patient becomes increasingly aware that abduction and rotation cause pain or that they are becoming limited in amount.

The shoulder joint is one of the most unstable joints in the body, as it necessarily must be in order to permit a wide range of motion. It is a non-weight-bearing joint. Also, it is one in which the weight of the arm in any position in use and, especially, in relaxation tends to pull the joint surfaces apart, thus putting strain on the ligaments of the capsule and the muscles. The bones which make up the shoulder joint, and which have a more or less direct influence on the joint, are not only the scapula and the humerus but also the clavicle, sternum, ribs, and spine[7].

The scapula, like all bones, is subject to great variations in shape. The only variation that will be noted in this paper is that which occurs in the region of the glenoid cavity. In some scapulae the angle formed by the glenoid cavity and the external border of the scapula is much more acute than in others (Fig. 1). There is also a difference in the direction in which the glenoid faces in relation to the body of the scapula itself. In some instances it faces in a more upward and backward direction, and in others in a more outward and lateral direction. These differences are of importance, but of more importance is the effect which the position of the whole scapula has on the position of the glenoid itself. With the scapula in the correct mechanical position (Fig. 2), the glenoid faces upward, outward, and slightly backward, making a definite shelf upon which the head of the humerus may rest. In this position, because of the position of the strong ligaments on the upper surface of the capsule, and because of the pull of the long head of the biceps, gravity and the weight

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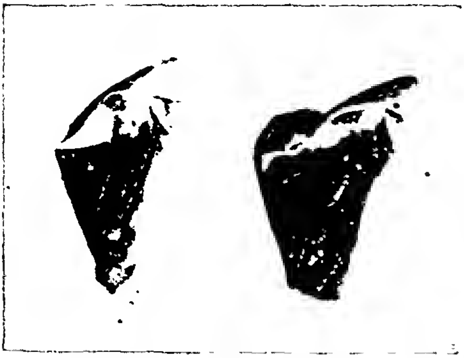

FIG. 1

Posterior view of two scapulae. Note difference in the shape of the bones. Note especially the difference in the angle formed by the glenoid cavity and the external border of the scapula, also that the glenoid cavity of the smaller scapula faces more posteriorly and upward than that of the larger scapula. Note that in both of these scapulae the lower border of the glenoid forms a definite shelf upon which the head of the humerus may rest.

of the arm force the head of the humerus into the glenoid cavity. When the head of the humerus is thus forced into the glenoid cavity, the greatest part of the capsule itself, as well as the muscles running from the scapula to the head of the humerus, becomes relaxed [8] and the humerus tends to rotate outward into the so called anatomical position with the palm forward (Fig. 3-A).

With the scapula in the incorrect mechanical position, as occurs in poor body mechanics and in the forward-drooped shoulder, the scapula rotates forward, outward, and downward[9]. In this position, the glenoid cavity changes the direction in which it faces and, instead of facing upward and outward and forming a shelf for the head of the humerus, it now faces outward and at times even downward, thus lessening or entirely eliminating the shelf upon which the humerus should normally rest. Thus the bony support given to the head of the humerus by the glenoid is lost and all the weight of the arm must come on the muscles and ligaments which normally protect the shoulder joint. In addition to this loss of bony support, the rotation of the scapula causes the humerus to rotate inward (Fig. 3-B), thus relaxing the strong ligaments on the upper surface of the capsule so that the head of the humerus tends to fall forward and downward and away from the glenoid cavity. The action of the long head of the biceps is also brought to the anterior side of the head of the humerus, so that its action of forcing the head of the humerus into the glenoid is lost.

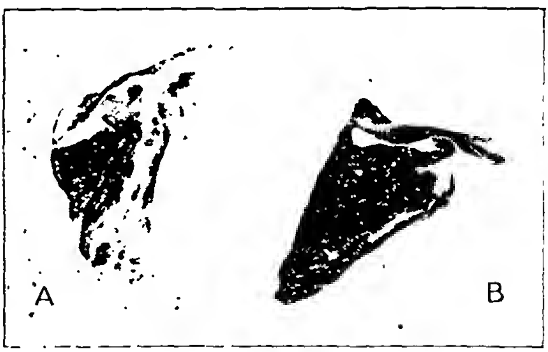

FIG. 2

A. This scapula is in the normal or correct position. The glenoid cavity forms a shelf for the head of the humerus to rest upon. The spine of the scapula points upward.

B. This scapula is in the position assumed in the forward-drooped shoulder. The shelf support of this glenoid cavity is lacking. The spine of the scapula points almost straight outward laterally. In this position of the scapula, the entire weight of the arm must come on the ligaments of the capsule and the muscles.

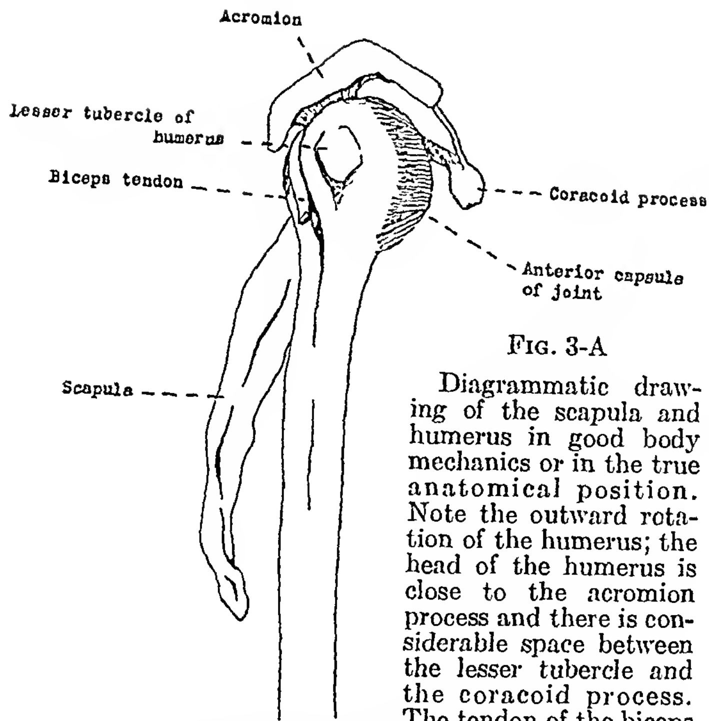

FIG. 3-A

Diagrammatic drawing of the scapula and humerus in good body mechanics or in the true anatomical position. Note the outward rotation of the humerus; the head of the humerus is close to the acromion process and there is considerable space between the lesser tubercle and the coracoid process. The tendon of the biceps (long head) is posterior to the middle of the shaft of the humerus and tends to hold the head to the shelf of the glenoid cavity.

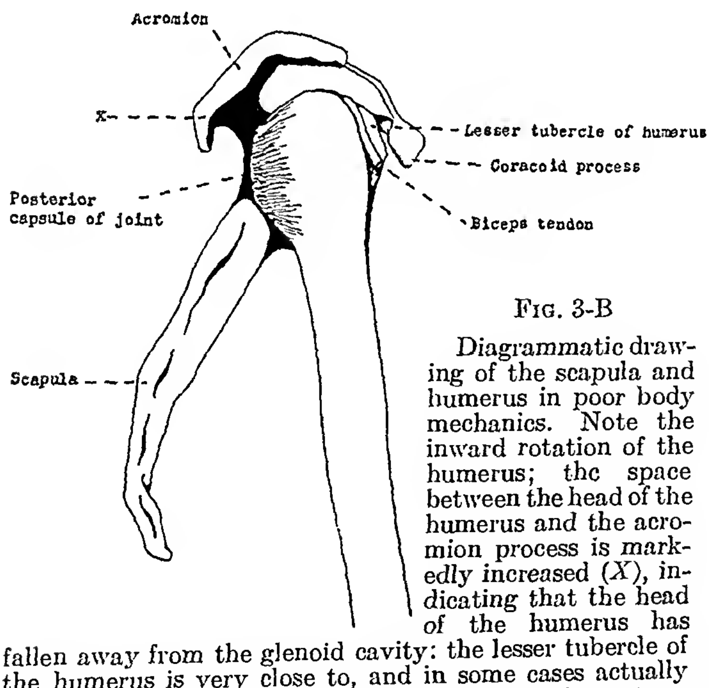

FIG. 3-B

Diagrammatic drawing of the scapula and humerus in poor body mechanics. Note the inward rotation of the humerus; the space between the head of the humerus and the acromion process is markedly increased (*X*), indicating that the head of the humerus has fallen away from the glenoid cavity: the lesser tubercle of the humerus is very close to, and in some cases actually impinges on, the coracoid process, as can be seen in anatomical specimens. The tendon of the biceps is anterior to the middle of the shaft of the humerus. Because the shelf of the glenoid is lacking and the head of the humerus is falling away from the glenoid, the biceps tendon cannot act to hold the head of the humerus to the shelf of the glenoid.

All the muscles which support the shoulder girdle have their origin in the spine, skull, or thorax; the action of these muscles, therefore, is influenced more or less by the position and shape of the spine and ribs. When the spine is used in a position of good body mechanics (Fig. 4-A), both the cervical and dorsal curves are nearly flat, there being slight flexion of the dorsal spine and slight or no extension of the cervical spine. This means that the spine is at its position of greatest length, and that the ribs are held up not only by the muscles, but also by the action of the vertebrae and transverse processes. This leverage action on the ribs forces the sternum upward and forward, thus raising the sternal end of the clavicle. When the sternal end of the clavicle is raised, there is a backward thrust upon the acromial end of the clavicle, which pushes the scapula and the humerus backward. In this position, the anterior part of the shoulder is nearly at

Fig. 4-A

Good body mechanics, showing the nearly straight cervical and dorsal spines. In this position, the chest is held upward and forward and the anterior tip of the shoulder (note the black spot) is nearly at, or even posterior to, the transverse sagittal plane of the body, or about half way between the front and the back of the body. In this position, the humerus tends to rotate outward, and the back of the hand tends to point outward or even backward.

Fig. 4-B

Faulty body mechanics, showing the increased cervical and dorsal curves with the accompanying forward droop of the shoulder. The anterior tip of the shoulder is markedly in front of the transverse sagittal plane of the body and may be even as far forward as the front of the sternum. In this position, the humerus naturally rotates inward, and the back of the hand tends to point forward. Compare with Fig. 4-A.

or even posterior to the transverse sagittal plane of the body. In this position, there is a bony shelf upon which the head of the humerus rests.

When the spine is used in poor body mechanics[10] (Fig. 4-B), the backward thrust of the clavicle is lost, and the shoulder droops forward and downward, the anterior part being in front of the mid-line of the body, at times even as far forward as the front part of the sternum. Such a position necessarily means the loss of the bony shelf and the weight of the arm, which is from eleven to sixteen pounds, comes on the muscles and ligaments.[11] The position of the scapula in the posterior view also changes. In the position of good body mechanics, the spine of the scapula is at an acute angle with the base upward to the line of the spinous processes. In the forward-drooped position, the spine of the scapula will be nearly horizontal, or at a right angle to the spinous processes.

When the spine and scapula are used in good body mechanics, the ligaments tend to hold the humeral head into the glenoid cavity without the action of the muscles. In poor body mechanics the ligaments no longer act in this way and, consequently, there is strain on the muscles. In the forward-drooped position of the scapula, the action of the muscles is likewise changed. The inward rotation of the head of the humerus brings the origin and insertion of the internal rotators closer together and the origin and insertion of the external rotators farther apart, thus, to some extent, interfering with their normal tone and action, as neither a shortened nor a stretched muscle can work as well as one normally placed. Perhaps the most important effect of the forward-drooped position is on the supraspinatus muscle and tendon. As the tendon of this muscle passes over the top of the shoulder joint to be attached to the greater

tubercle of the humerus, it forms the floor of the subacromial bursa. The forward-drooped position of the shoulder girdle, combined with the inward rotation of the humerus which allows the head of this bone to fall away from the glenoid cavity, puts the supraspinatus tendon and muscle on the stretch and also makes a less direct pull on its attachment. In such a stretched position, the tendon is more susceptible to strains from sudden muscular actions or falls. In cases where the mechanics of the shoulder are habitually faulty, frequent slight injuries may lead to adhesions in the bursa or even to calcareous deposits in the supraspinatus tendon.[12]

In the forward-drooped position of the scapula, with the consequent internal rotation of the humerus, the lesser tubercle may be brought into contact with the coracoid process. There is great variation in the shape, size, and length of the coracoid process, as well as in the angle which it forms with the scapula. The possibility of impingement of the head of the humerus on the coracoid process is considerable in some individuals and in others slight, but, no matter what the size or shape of the coracoid may be, the possibility of impingement is greatly increased by the forward-drooped position of the shoulder girdle.[5]

When the mechanics of the shoulder girdle are understood, and it is recognized that the forward position of the shoulder allows the head of the humerus to fall away from the glenoid cavity, the reason for many recurrent dislocations of the shoulder is more easily seen. The position of good body mechanics, which forces the head of the humerus into the glenoid cavity, carries out the principle of all the operations for recurrent dislocations[13],—namely, that of holding the head of the humerus in contact with the glenoid. It is quite possible that some of the failures of operations for recurrent dislocation would not have been failures if the mechanics of the spine, the chest, and the shoulder girdle had been corrected either before or after the operation.[14]

The treatment of disabilities and pain around the shoulder must be not only local, but also planned to correct the accompanying faulty mechanics of the body as a whole. The ideal treatment for an acute case is to put the shoulder and arm in the best mechanical position for rest and stability. This can be accomplished by putting the patient to bed on the back either with no pillow or with only a small one under the head, and a large pillow under the knees for comfort and to relieve the back. A pillow may be placed under the elbow and forearm of the affected side, but the shoulder should be allowed to settle back on the bed so that the humerus will fall back into the glenoid cavity. A change of position of the arm can be obtained by attaching the hand and forearm by traction to a five-pound weight suspended from the head of the bed. This position sometimes removes the strain on the subacromial bursa and often lessens the discomfort. It also permits some motion, and motion which causes no pain is not harmful. Heat applied locally, particularly in the form of hot fomentations, is helpful. Whether or not forcible manipula-

tion is necessary depends upon the severity of the case, but it has been found that, since the mechanical elements influencing the shoulder girdle have been more fully understood, the cases needing manipulations to recover motion have been fewer in number.

Treatment in recumbency during the acute stage of the disability shortens the time of the acute symptoms and gives an excellent opportunity for beginning the correction of the mechanics of the whole body. During the time of recumbency, special education for training the muscles to maintain the position of good body mechanics should be started. As soon as the acute symptoms have disappeared, and in those cases in which bed treatment is not possible, the position in which the shoulder is used must be carefully supervised. The so called anatomical position should be the position sought,—*i. e.*, with the shoulder up and back, and with the whole arm rotated outward so that the palm of the hand is forward. This is the most stable position for the shoulder joint, and this puts the least amount of strain upon the bursa and other structures. Where it is difficult for the patient to maintain this position of the shoulder, elastic shoulder straps, attached to a corset or back brace and worn temporarily, will help in holding a good mechanical position of the shoulder and of the body. Lasting cure and the absence of recurrence can be definitely assured only if the correct mechanics of the shoulder joint are consistently maintained.

CONCLUSIONS

Painful conditions about the shoulder joint are commonly associated with the forward-drooped position of the shoulder girdle. The mechanics of the shoulder girdle are such that, with the drooped position of the body as a whole, the habitual position of the shoulder is one of constant strain upon the structures which stabilize the shoulder joint. The correction of the drooped position of the body, as well as the position in which the shoulder is habitually used, should be an essential part of the treatment in disabling conditions about the shoulder.

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OSTEOCHONDRITIS OF THE PATELLA

Including a Case with Multiple Epiphyseal Involvement

BY MOSES GELLMAN, B.S., M.D., BALTIMORE, MARYLAND

From the Departments of Orthopaedic Surgery of the Schools of Medicine of the Johns Hopkins University and the University of Maryland

The so called osteochondritides have gradually gained more and more attention since Osgood [1] in 1903 described a non-traumatic affection of the tibial tubercle, so that, according to Harbin and Zollinger, there has accumulated a bibliography reaching approximately 700 articles. These conditions, which are generally regarded as being fundamentally similar processes with similar characteristics, though occurring at different age periods, have been collectively grouped under the term "osteochondritis", which term may be taken to denote a "non-inflammatory, non-infectious derangement of the normal process of bony growth occurring at the various ossification centers at the time of their greatest developmental activity" (Buchman). During the last decade osteochondritis has been found, by numerous observers, to occur at practically every ossification center that is subject to stress and strain.

Buchman [2] and Harbin and Zollinger [3] have in their papers adequately reviewed the anatomical considerations, classification and terminology, clinical pictures, etiology, pathology, roentgen appearance, treatment, prognosis, and differential diagnosis of every important ossification center that is commonly involved. There is, however, a certain amount of justification in presenting two cases of the patellar variety, since the patella does not often seem to be the seat of this process; for reports concerning this variety are but sparsely scattered throughout the literature. The first case represents the simple primary type of osteochondritis; the other, the secondary type, involving to a marked degree the patellae, in combination with multiple lesions elsewhere,—the tibial tubercles and ossa calcum.

CASE REPORTS

Case 1. R. L., 834, a white boy, aged six, was admitted to the Kernan Hospital for Crippled Children from the Orthopaedic Dispensary of the University of Maryland on January 16, 1930, because of pain in hoth knees. For several months he had tired easily and occasionally complained of pain, first in one knee and then the other. There had never been any swelling, redness, local heat, or elevation of hody temperature.

The general physical examination was essentially negative, except for mild tenderness of the patellae which felt of normal size and shape. There was no restriction of motion in the knees. Lateral roentgenograms revealed small, ragged knee caps with numerous areas of lessened density and incomplete ossification, and a tendency to fragmentation at the lower poles. The anterior-posterior views showed faint but definite evidences of fragmentation. The child was allowed to rest in hed for seventeen days without support of any kind. The tenderness was on the verge of entirely disappearing

Fig. 1

Case 1. Small ragged patella with numerous areas of lessened density and incomplete ossification. Tendency to fragmentation at lower pole.

when he was removed from the hospital.

He was not seen again until May 26, 1932, two years and four months later, when he was sought for the purpose of rechecking the x-rays. He had long since been relieved of all discomfort in the knees. Roentgenograms showed a nearly complete restitution of the bony structure in both patellae, though they appeared larger than one would expect at the age of eight. The trabeculations were somewhat coarser than usual and there were several sharp spiculations about the periphery at various points.

Case 2. J-42684, Johns Hopkins Hospital Dispensary. R. S. was a white boy, aged twelve, who came to the clinic on February 21, 1930, complaining of pain in the right knee; the onset dated back one year, when he had developed a "kink" in the right knee, particularly while ascending stairs. A little later there was discovered a small, round swelling on the right knee cap, towards the outer upper edge, which, until recently, had never been very tender or inflamed. The boy limped occasionally, particularly after much activity; but lately the knee seemed to be becoming more troublesome. There was no history of fever, sweats, night cries, or involvement elsewhere, except that once in a while his feet would get tired.

Physical examination showed a well developed boy, with a tendency to obesity, though rather undersized for his age. The head seemed larger than usual. The skin was generally scaly and dry, due to congenital ichthyosis. There was some lowering of the longitudinal arches with abduction of the feet. There was no atrophy of the thighs or calves.

Movements of the knee joints were free and painless, with no capsular thickening or increase in joint fluid. On the outer upper pole of the right patella was a small, smooth, rounded elevation, not reddened, but very tender and slightly warm to the touch. The contour of the patella seemed otherwise smooth, and elsewhere was free from pain on pressure. The left patella was clinically negative in all respects. All other available epiphyses were free from pain and tenderness.

Although the diagnosis was deferred, roentgenograms were ordered of both knees for the suspected presence of an epiphyseal disturbance. The lateral view of the affected right side showed a marked disorganization of the bony structure of the patella. The upper pole was almost completely separated from the body of the patella and there was also a cleft running vertically from top to bottom that seemed to divide the anterior one-fourth of the patella from the remaining portion. There were numerous areas of lessened

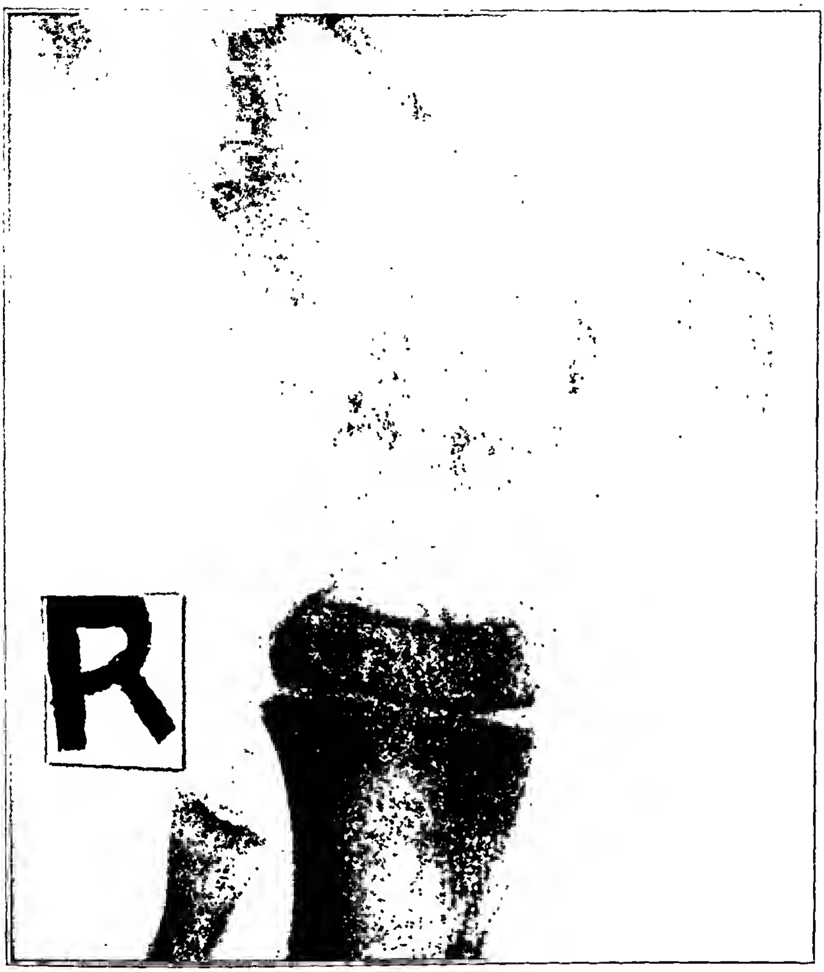

Fig. 2

Case 1. Two years and four months later. Nearly complete restitution of bony structure in same patella as in Fig. 1. Trabeculations coarse and several spiculations about periphery at various points.

density and incomplete ossification. The lateral view of the unaffected left side was even more disorganized and moth-eaten. The anterior-posterior view of the right patella showed fragmentation of the upper half, the largest fragment being on the outer corner where clinically the bone was tender. In addition, irregularities were discovered at the osteochondral borders of the lower epiphysis of each femur, more particularly on the left side. Thus it was discovered that, while the signs and symptoms were confined to the right patella, roentgenographically the left patella was as much disorganized, in some respects more so.

On February 24, 1930, attention was given to the flat feet and the right leg was put in a circular plaster cast. On March 18, 1930, three weeks later, this was removed, but, as no special improvement was noted, it was replaced. On May 26, 1930, three months after the first immobilization, all tenderness had disappeared. He had received no treatment for the left knee, which, it will be remembered, showed identical changes. Roentgenograms taken at this time showed some improvement in the structure of the patellae.

About five and a half months after the first visit, both knees were symptomless. The

FIG. 3

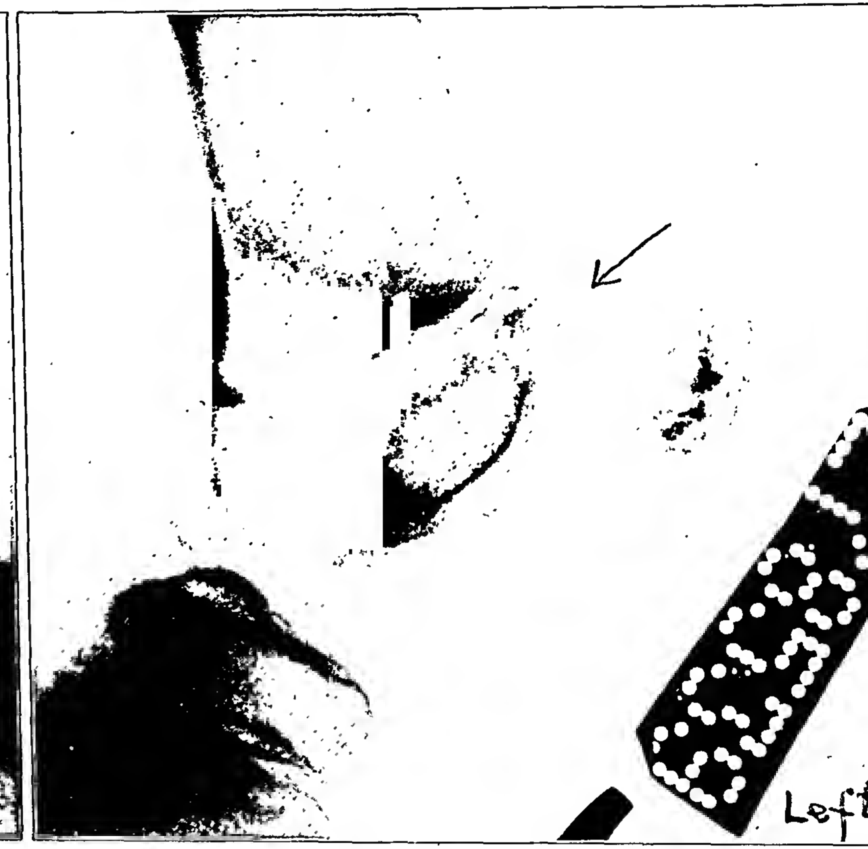

FIG. 4

Case 2. Right side clinically active. Left side clinically negative. Both patellae show marked disorganization of their structure, with fragmentation, splitting, areas of lessened density, and incomplete ossification. Note irregularities at osteochondral borders at the lower end of each femur (arrows).

patellae felt firm, somewhat larger, were not tender, and the knob originally present on the upper outer aspect of the right knee was only slightly palpable. Roentgenograms of the right knee cap showed that all the fragmented portions had fused, though the structure of the bone was still mottled and not uniform in density. The patella seemed larger and was somewhat crescent-shaped, since the upper pole was beak-like in contour. The left patella still showed signs of fissuring, but the bone was more compact and calcium-laden. There was still some fuzziness at the osteochondral border of the lower femoral epiphyses.

FIG. 5

Case 2. Considerable fragmentation along superior and medial borders. Anteroposterior view of Fig. 3.

On September 30, 1930, seven months after the first visit, the boy reappeared, complaining of pain in the heels of several weeks' duration. At the insertion of each Achilles tendon into the os calcis, there was considerable tenderness, and pain was elicited on lateral compression of the posterior portions of the heels. No swelling, redness, or elevation of local or general temperature were noted. A diagnosis of apophysitis of the ossa calcum was made. Roentgenograms confirmed the impression, though on the left side only. There was hardly time for the strapping and rest to take effect when, three days later, the patient returned, complaining of pain below the left knee where tenderness, fullness, and thickening were localized over the tibial tubercle. A further diagnosis of osteochondritis of the left tibial tubercle was made. Because this epiphysis was hardly manifest as yet, roentgenograms showed only a peculiar dishing or cupping at the site where the tibial tubercle was to be and were only suggestive of the condition diagnosed. Clinically, however, it was a typical case of involvement of the tibial tubercle. In the meanwhile the patellae had continued to get denser and more uniform in quality, although there were still areas of irregular calcification scattered throughout the substance of the bones.

This case had by now been observed for a period of nearly eight months, during which time the patient had undergone osteochondritic involvement of three sets of growth centers,—the patellae, ossa calcum, and tibial tubercles. Roentgenograms of the entire skeleton were made and the only other important finding was some thinning of the sella turcica with a suggestion of internal hydrocephalus.

Laboratory data were as follows:

Wassermann reaction: negative.
Basal metabolic rate: — 6 per cent.
Blood sugar: 75.30 milligrams per 100 cubic centimeters.

FIG. 6

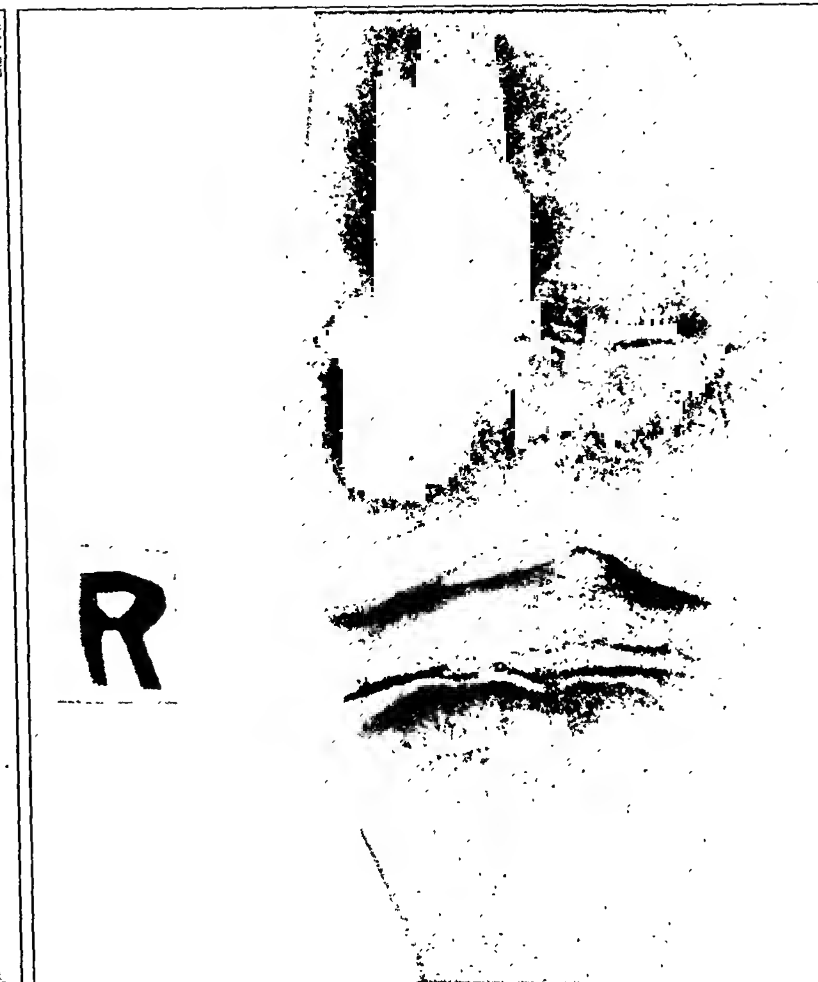

FIG. 7

Case 2. Sixteen months after first visit. Patella now large, well formed, and more condensed. The trabecular structure is better delineated. Note beak-like knob on upper pole. Arrow points to increased cupping at the site of future tibial tubercle (better seen on original plate). Compare with Figs. 3, 4, and 5.

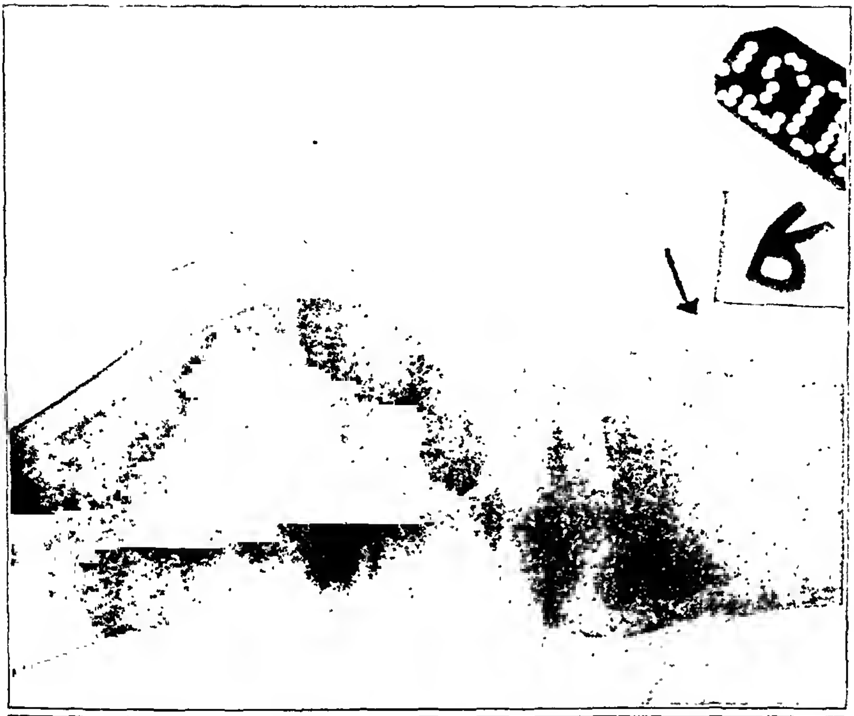

Fig. 9

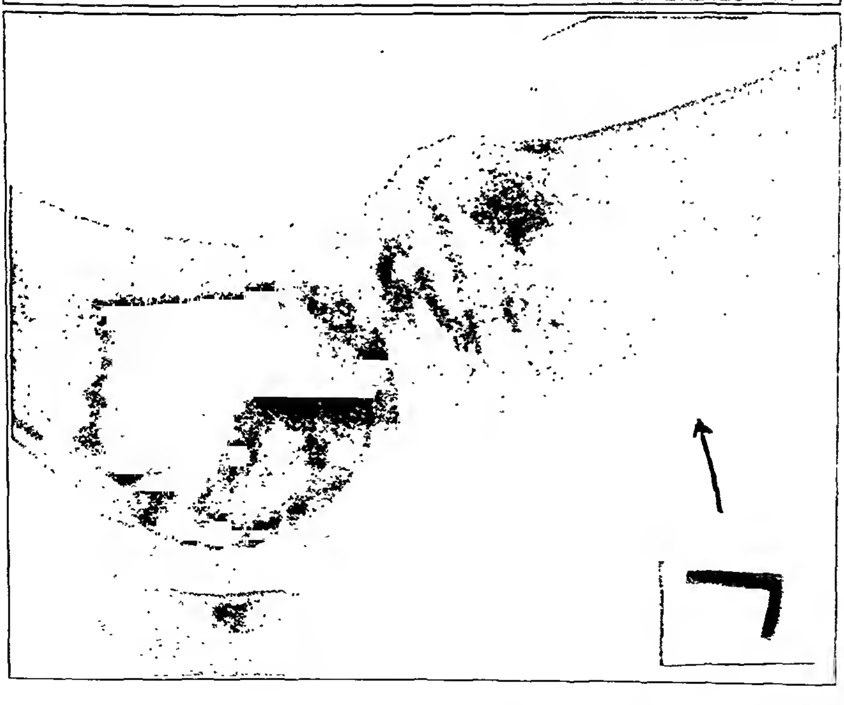

Fig. 8

Case 2. Two years and four months after first visit. Patellae somewhat thickened and larger in both diameters. Tapering at upper poles which may be due to quadriceps pull. Area of lessened density in upper third of right patella. Typical roentgenographic findings of osteochondritis of tibial tubercles after twenty months of clinical activity.

Blood calcium: 8.40 milligrams per 100 cubic centimeters.
Blood phosphorus: 5.22 milligrams per 100 cubic centimeters.

The boy was seen at irregular intervals from November 1930 until June 1931. His symptoms were confined to the tibial tubercles and ossa calcum; he felt better some days, but worse after strenuous activity. The roentgenograms of June 8, 1931, sixteen months after his first visit, revealed that there was more of a depression where the tibial tubercles would eventually develop. The patellae were now large, well formed, and more condensed; the trabecular structure was better delineated and there had developed small beak-like knobs on their upper poles.

He was for the last time observed on June 22, 1932. He had developed into a short, stubby youth. The patellae were still symptom-free, but the tibial tubercle areas were full and tender. Roentgenograms for the first time, twenty months after the original complaint at these sites, showed the usual irregularity and roughening of their particular growth centers. The right patella, the involved one, now after two years and four months, was thickened and longer. There was an area of lessened density in its upper third and the upper pole had a tapering aspect. The left patella, except for seeming to be larger, had a normal internal structure. The fuzziness at the femoral epiphyses had disappeared.

DISCUSSION

The first case of osteochondritis of the patella was reported by Köhler[4] in 1908, in the same paper in which he described the better known, related condition involving the tarsal scaphoid. In 1921 Sinding-Larsen[5] and in 1922 Johansson[6] independently recorded cases of a similar nature. Hawley and Griswold[7] reviewed Larsen's and Johansson's six cases and added two of their own. Moffat[8] described a case in which he was able to get pathological sections at operation; these sections showed that there was no evidence that the bone condition itself was inflammatory in character.

More recently Harbin and Zollinger[3] have classified the types of osteochondritis as primary or secondary, depending upon whether the primary or secondary center of ossification was involved. Since ossification of the patella commences at the age of five or six years, the primary type of osteochondritis is common at these ages when this center is rapidly growing. Rarely the patella will develop secondary centers of growth at about puberty. When they do appear and are involved in the osteochondritic process, secondary osteochondritis results. In the light of this classification, Köhler's case was of the primary type; Larson's and Johansson's cases of the secondary type; Moffat's, primary; and Hawley and Griswold's of the secondary group; while the two cases here presented would be primary and secondary, respectively.

The patella is often subject to various developmental anomalies, having accessory centers of ossification, usually at the outer margin of the bone. It is well known that erroneous diagnoses of vertical fractures have been made until roentgenograms of the opposite patella revealed a similar anomaly. Such defects, when present, are bilateral in two-thirds of the cases. These aberrant ossification centers, instead of fusing with the main body of the bone, may persist as separate centers at either pole. If an osteochondritic process intervenes, it is but natural that all compo-

nents of the bone are similarly involved. Being subject to strong pull above by the quadriceps tendon and below by the patellar tendon, the patellae may be found to be subject to the irritative effects of severe traction. Occasionally the osteochondral line of the lower femoral epiphysis, as well as the tibial tubercle, is involved, since these two sites are within the vulnerable area of this strong pull.

Mau[9], after reviewing the European literature, reported four cases of this condition, one of which, however, formed the basis for most of his discussion in this paper; and he continued this discussion in another later article[10]. His patient was a boy, nine years of age, who complained of continuous pain in the right knee. A year before, early tuberculosis was suspected. Lateral roentgenograms showed complete disorganization of the bony structure of the patella. Roentgenograms taken over a period of eight years, until the age of seventeen, showed that the irregular areas of calcification gradually disappeared. Finally the trabecular structure became coarse-meshed and the patella was enlarged somewhat in both the long and short diameters. In many respects his patient resembled very closely the second case in this report.

In Mau's case destruction and regeneration of the bony structure of the patella occurred. According to the roentgenographic findings, the pathologico-anatomical processes looked like those of Legg's disease of the capital epiphysis of the femur and those of Köhler's disease of the tarsal scaphoid bone. This author believed that the condition was an aseptic necrosis of the patella due to nutritional disturbances. His theory was supported, he thought, by the findings in experiments carried out on animals by Wollenberg and Axhausen. The cartilaginous nucleus of the patella, he stated, is supplied by some of the arteries from the articular rete of the knee. These vessels run over the anterior surface of the patella from below and from the side, and then enter vertically into the canaliculi of the medullary cartilage of the inner cartilaginous nucleus, where they branch out. With the development of the spongiosa nucleus, the canaliculi of the medullary cartilage undergo regression. As the vessels must penetrate a thick layer of cartilage before the bony nucleus reaches the surface of the cartilaginous patella, Mau believed that the injury of the patellar vessels occurs at the points where the vessels are subjected to the powerful pressure and pulling effects from the attachments of the quadriceps tendon. Aseptic necroses follow these embolic manifestations and account for the alterations in the structure of the patella. It can thus be seen that, while the pull and pressure factors are active in all normal subjects, apparently circulatory defects, similar to those described by Mau, must also be assumed to be present in a given subject before these peculiar osteochondritic changes occur.

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INTRACAPSULAR HIP FRACTURE

BY FREDERIC JAY COTTON, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

The time is ripe for reconsideration of our methods of treatment of *fresh* intracapsular hip fractures.

The time is ripe because at a time when everyone is unhappy over routine results, fresh developments in x-ray technique have made it possible to study our cases better and to check up exactly on our reductions.

There is no need here to go at length into statistics. Suffice it to say that most if not all of us feel that even in the best hands the results are inconstant,—in gross, rather lamentable.

Recent studies, roentgenographic and histological, have cleared the ground so that certain statements can be made safely.

We know now that union *should* occur and is dependent on *exact* reposition and contact, not on

Age,
Health,
Lime,
Live or "dead" bone.

We have learned the need of actual reductions; very few cases are in perfect enough position to leave as we found them.

Conversely not many, even of the aged, are unfit to treat.

The problem in cases of fresh fractures is that of *reduction,* then fixation.

A period of over two weeks following injury is a handicap, but does not mean that reduction is not worth while. Reduction earlier than four days is in many cases unwise because of the early upset due not so much to shock in the broad sense as to the visceral disturbance from sympathetic nerve upset.

Accidental impaction is of no value unless it is in such position as

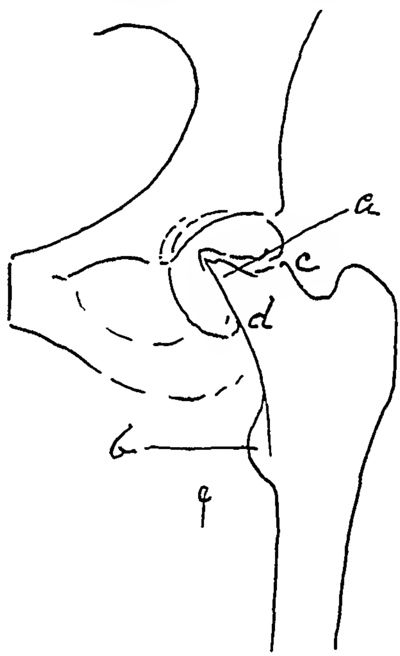

FIG. 1

One usual form of false impaction. This is really only an impalement of the head on the sharp spur on the distal fragment, shown as *a*. The very unsatisfactory situation is readily understood when one notices that there can never be any repair across from fragment to fragment for the distance between *a* and *d*, because this part of the distal fragment is covered with periosteum. Only from *a* to *c* can there be possible adhesion or bridging, and here, as we shall see in the other views, there is rarely any contact. Note also that the prominence of the lesser trochanter *b* is definite proof of marked external rotation, uncorrected.

to give exact apposition, and that is rare, in our experience.

The usual picture is that of a bare impaling entanglement, not a true impaction (Fig. 1).

Merely putting fractures of this sort into a given position in plaster is not enough.

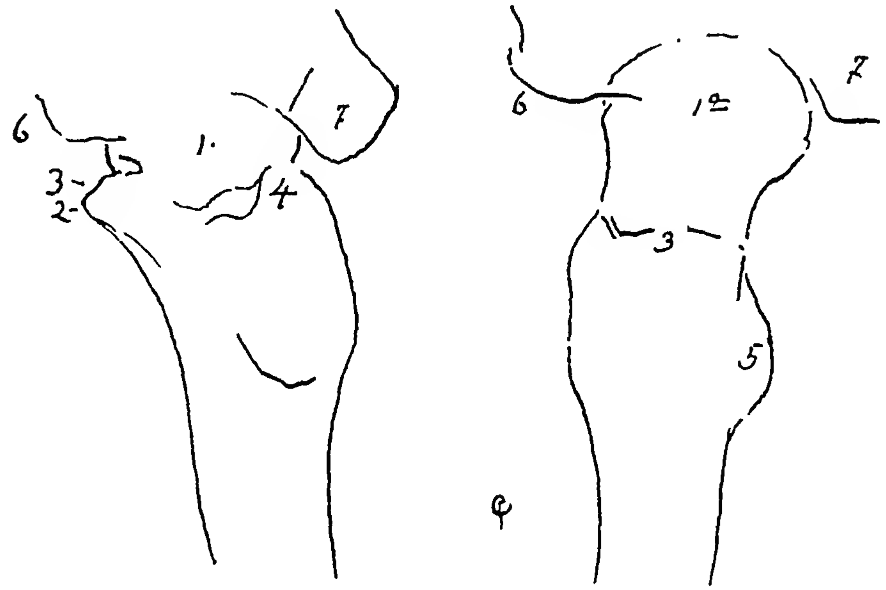

FIG. 2

Lateral view, with the convex cassette in the "saddle" position, looking down and in on the film.

In the left-hand figure, *1* is the head; *2*, the corner of the distal fragment rotated sharply forward; *3*, broken surface of distal fragment out of all contact with other bone; *4*, greater trochanter; *6*, pubes; *7*, ischium.

In the right-hand figure, *1ª* is the head; *3*, the fracture line in practically perfect alignment; *5*, the lesser trochanter, brought into view as the shaft is rotated inward.

Actual reduction is called for.

All of us have failed in exactness of reduction. This is evident from study of real lateral views which commonly show, even after apparently decent replacement, a rotation forward and a little displacement upward of the distal fragment, so that the broken surface of the neck has *no* bone contact, and the inner surface of the neck a contact with the broken face of the head (Figs. 2 and 3).

This condition calls for definite reduction, and it is so complicated that any routine reduction without check is likely not to be exact, even in the best hands. For this reason, among many, these patients should be treated in hospitals. Nearly all such cases should be actively treated, not neglected on the excuse of age.

Reduction—Conditions

Fracture relatively recent.

Anaesthesia of some sort.

X-ray table to work on.

Curved cassette for "saddle" view.

Gas oxygen and ether, advisable; spinal anaesthesia of course, practicable. In high tension cases, scopolamine and morphine may be the best.

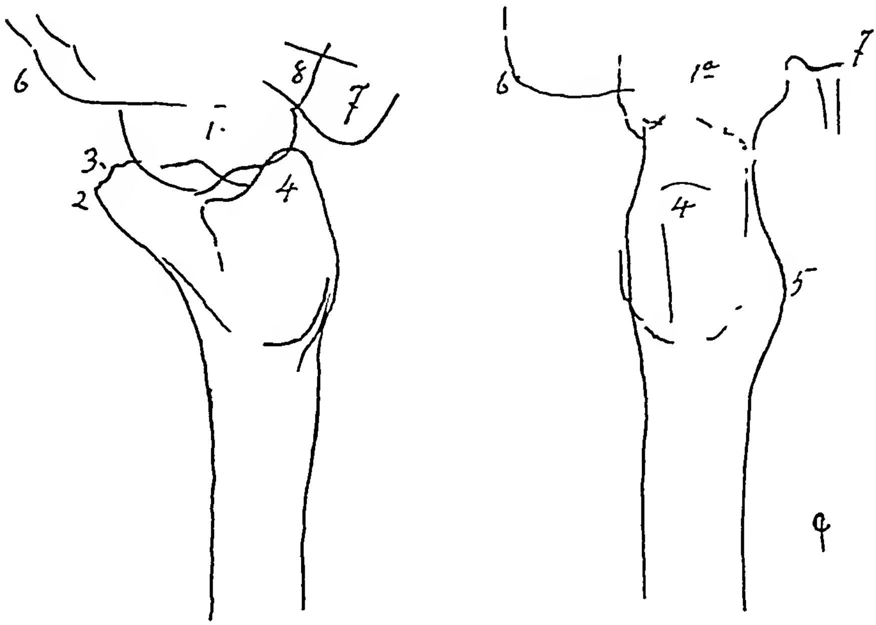

FIG. 3

In the left-hand figure, *1* is the head; *2*, the anterior corner of the neck rotated, as usual, forward (in outward rotation of the whole shaft); *3* shows the broken surface out of contact with other bone,—in fact, this broken surface out of contact almost certainly includes the whole width of the neck, as seen here; *4*, the greater trochanter; *6*, pubes; *7*, ischium, and in this case *8* shows the posterior wall of the acetabulum.

Numbers on the right-hand figure, the same, except for the addition of *5*, the lesser trochanter, brought into view by the rotation of reduction. The fracture line here is not sharply shown. There is, however, no question about the accurate alignment of the parts.

R. D. Leonard and A. W. George (*The American Journal of Roentgenology and Radium Therapy,* XXVIII, 261, 1932) put on record this "cassette method" for taking what I call the "saddle" view, apparently the first fully practicable method of getting lateral views. The cassette is simply a curved film holder which is pushed up into the crotch between the abducted legs. The x-ray tube shoots down from one side near the shoulder, so as to get both the neck and some part of the head. The method is technically difficult for the roentgenologist, needing a little practice in gauging what would seem like overexposure. The views are frankly a little distorted, but one learns to read them comfortably with very little practice.

Stereoscopic films do not tell the story, although they may be of great value.

Reduction—Manoeuvers

Traction in moderate abduction with thirty degrees' flexion of hip.

Adduction—across other thigh.

Internal rotation—forced.

Return to abduction—slight—without relaxing the internal rotation.

Then check with x-ray (saddle view).

Re-reduce if need be.

Impact with hammer or sand bag.

Put up in spica.

Recheck with x-ray.

There is real advantage in using the double spica, taking in the whole of the affected side, down to just below the knee on the other side, with a cross bar from knee to knee. This gives fixation without carrying the spica up onto the ribs, and it may be so applied as to leave most of the abdomen free without loss of fixation. Moreover, I have found it better in holding position than any form of single spica, and easier for the nurses to handle in the very necessary turning of the patient on the face for care of the skin and airing out of the lungs.

After-Treatment

Cast cut away in front from high on thigh to well below the knee.

Massage of muscles front of thigh and massage of knee.

Motion (very carefully) carried out twice daily, and for no great range.

X-ray check every few days.

Cast off at ten weeks.

More motion.

Convalescent splint at twelve to sixteen weeks.

Later Care

Depends on the x-ray picture.

With little absorption—live head, no loss of position, probably a little weight at four months.

Real weight-bearing never for six months.

In cases of dead head, protection till regeneration is complete.

(Phemister has shown that, if the dead head is kept clear of weight-bearing pressure for a sufficient time, regeneration becomes complete and the deformation of the head, late, is at least not likely to occur.)

We have specimen cases, but more time is called for to accumulate series data.

But, while the stress on internal rotation, starting with Peckham, and on abduction, so long advocated by Whitman, has brought about better results, yet it is undeniable that most surgeons *have not reduced* the displacement.

We can reduce, and *can now check* our reductions.

As to open operation, it can at best do no more than reduce.

Reduction once accomplished, the tendency to recur is but small, *provided* internal rotation is kept up.

Fixation by nails or grafts certainly traumatizes bone as well as soft parts, probably interferes with repair somewhat, and logically seems superfluous.

With exact apposition of surfaces, artificial impaction offers quite as much advantage, at far less cost of shock and risk.

Therefore, it is respectfully but firmly suggested that we try real reduction, *accurately tested*, preferably with impaction as an added safeguard against displacement and an added assurance of contact of fracture surfaces, with maintenance in some abduction, with much internal rotation, and that this be thoroughly tried on all fresh fractures of this sort.

The above was written before the appearance of Leadbetter's article, which seems obviously sound, even if one cannot accept his test of the failure of the limb to flop back into external rotation as a test of solidity. This test as a measure of the success of artificial impaction has seemed in the past to have some real value, but it is not clear that it can really be relied on at all.

Study of position is of *first* importance, utilizing in full the amazing opportunity for a *real* check-up with the lateral films now available.

DECANCELLATION OF THE OS CALCIS, ASTRAGALUS, AND CUBOID IN CORRECTION OF CONGENITAL TALIPES EQUINOVARUS

BY FRANK E. CURTIS, M.D., AND FELIPE MURO, M.D.,
DETROIT, MICHIGAN

From the Orthopaedic Clinic of the Children's Hospital, Detroit, Michigan

The incompletely corrected and neglected club foot offers a complex problem which taxes the ability of the orthopaedic surgeon. This type of foot has been treated in our Clinic by correcting the soft-tissue deformity immediately by lengthening of the plantar fascia, lengthening of the Achilles tendon, and forcible manipulations and casts. Later, when the child was six to eight years of age, a corrective tarsectomy was done. Some of the results have been rather unfavorable, as the deformity persists for a long period of time; the growth of the foot and the development of the leg are retarded and considerable stiffness results. If the tarsectomy is done too early, a recurrence of the deformity is common, and destruction of the joints and growing centers gives an underdeveloped and stiff foot.

To obtain better functional results and shorten the period of disability, we have been using on this type of foot, during the past two and a half years, the operation to be described. This operation has been done on fifty-one children and on sixty-nine feet, due to a number of bilateral cases.

TECHNIQUE OF OPERATION

A short incision in front of the external malleolus is made on a line with the tubercle on the anterior portion of the os calcis, extending over the cuboid. The peroneus longus and brevis tendons are retracted toward the sole of the foot. The short dorsal flexor muscles (extensor brevis digitorum) are separated from their origin on the lateral side of the os calcis and retracted towards the top of the foot, thus giving exposure of the neck of the astragalus, anterior portion of the os calcis, and the cuboid. A small puncture wound is made in the three bones according to the diagram (Fig. 1). With successively larger curets, the cancellous portion of these bones is removed. All the cancellous bone is removed from the cuboid, while from the os calcis and astragalus only the anterior portion is removed. The foot is then forcibly overcorrected by manipulation with a Thomas wrench. To correct the metatarsus varus and decrease the convexity of the outer border of the foot, manipulation is done over a rectangular bar (Fig. 2).

When visible collapse of the bones is not evident after manipulation, the outer shell of the cortical bone of the cuboid and os calcis is split vertically, with scissors, to allow collapse. If necessary, in older children,

a section of the outer shell is removed from the bones mentioned, and the articulating surface is not disturbed.

The dissected muscle is then sutured in place and the skin is sutured with plain catgut. The leg is placed in a plaster-of-Paris cast extending from the mid-thigh to the toes, with the foot dorsiflexed and everted, the tibia rotated externally, and the knee flexed.

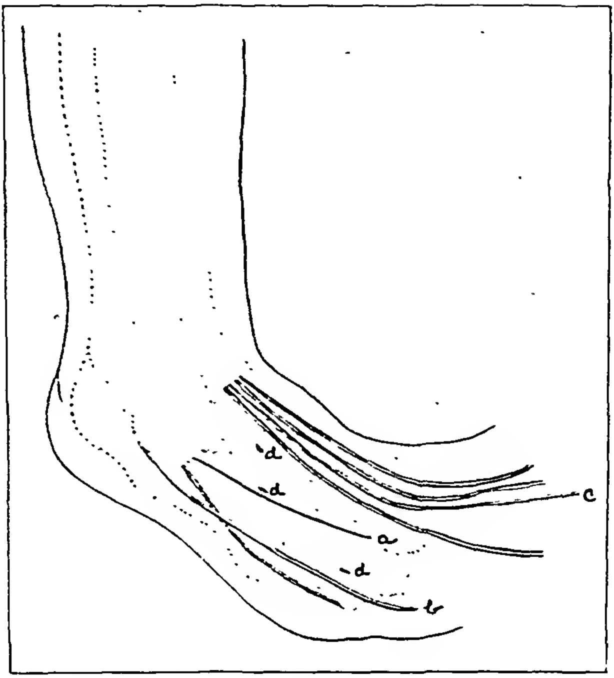

FIG. 1

Diagrammatic drawing showing:
a. Skin incision.
b. Peroneal tendons.
c. Dorsal flexor tendons.
d. Puncture wounds made in astragalus, os calcis, and cuboid.

POSTOPERATIVE TREATMENT

The first plaster is removed at the end of three weeks, and under anaesthesia a reapplication of plaster is made, after the foot has been manipulated to the overcorrected position. Plaster casts are applied in the overcorrected position for four months, after which an inside upright and outside T-strap brace is applied. Physiotherapy and muscle education are then carried on to develop the peroneal and dorsal flexor muscles of the foot. The brace is worn and muscle education continued until such time as the patient is able to actively place the foot in the fully overcorrected position.

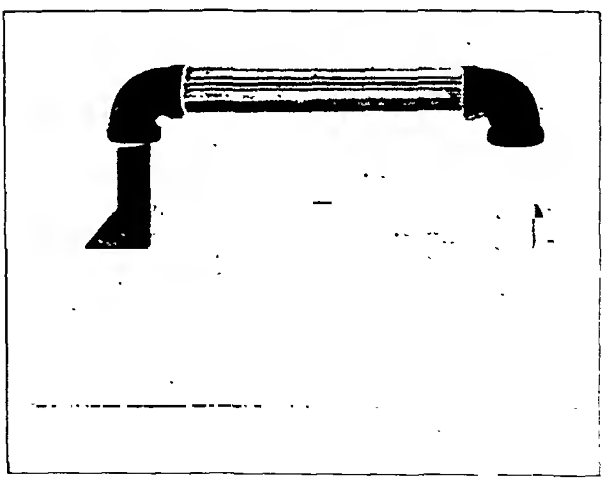

FIG. 2

SUMMARY

Summary of the fifty-one patients operated upon shows:

Right foot affected	12
Left foot affected	18
Both feet affected	21
Males affected	42
Right foot	10
Left foot	13
Both feet	19
Females affected	9
Right foot	2
Left foot	5
Both feet	2

In this series there was no patient with family history of similar deformity in the parents. In four cases other members of the immediate family (one sister and three brothers) had the same deformity.

In the majority of the cases it was necessary to perform Steindler's operation before the decancellation and the lengthening of the tendo achillis after the decancellation.

The youngest child on whom the operation was done was one year old, while the oldest was nine years of age.

A review of the end results shows normal appearing feet with good motion in sixty of the feet operated on. In eight the result was judged fair; in this group there were two cases of associated spina bifida occulta. In one case the result was poor, due to lack of cooperation from the parents.

X-RAY STUDY

A review of the roentgenograms of this series demonstrates that:

1. There has persistently been an alteration in the shape of the os calcis.
2. In most cases the shape of the astragalus and cuboid has been changed.
3. The outer border of the foot has been changed from a convex to a straight or concave surface.
4. The joint spaces were well maintained between the bones operated upon and there has been no disturbance in the growth of the bones.

REVIEW OF LITERATURE

Somewhat similar operative procedures in caring for congenital club foot were carried out by Meusel in 1890, by Ogston in 1902, by Lauenstein in 1903, by Mencière in 1908, and by Lamy in 1913. In 1931 André Trèves and Michel reported several successful results by this "open-operation" method.

The operation has been called "*évidement*" by Sédillot, Mencière, and Lamy and "*excochleation*" by Chlumský.

TABLE I

Case Reports

Case No.	Sex	Foot Affected	Family Deformities	Age at Operation (*years*)	Results
1	M	L	—	3	Normal motion and appearance.
2	M	R	Brother had club foot.	5	Normal motion and appearance.
3	M	B	—	4	Metatarsus varus persists.
4	F	L	—	9	Normal motion and appearance.
5	M	B	—	4½	Slight metatarsus varus persists.
6	M	R	—	4	Poor. Parents refused to cooperate.
7	M	B	—	4½	Normal motion and appearance.
8	M	L	—	1	Normal motion and appearance.
9	M	L	—	3	Normal motion and appearance.
10	M	L	—	2	Normal motion and appearance.
11	M	B	—	1	Right foot, normal; left, good motion but great toe is slightly adducted.
12	F	R	—	3	Normal motion and appearance.
13	M	R	—	5½	Normal motion and appearance.
14	M	B	—	3	Normal appearance; dorsal flexion slightly restricted.
15	F	L	—	4	Normal motion and appearance.
16	M	L	—	8	Normal motion and appearance.
17	M	R	—	4	Normal motion and appearance.
18	M	B	—	5½	Normal motion and appearance.
19	M	B	Sister had club foot.	5	Normal motion and appearance.
20	F	L	Brother had club feet.	6½	Normal motion and appearance.
21	F	R	—	1½	Normal motion and appearance.
22	M	B	—	2½	Right, normal; left, motion good, slight adduction of the great toe.
23	M	L	—	1	Normal motion and appearance.
24	F	B	—	1	Normal motion and appearance.
25	M	B	Brother had club foot.	7	Normal motion and appearance.
26	M	B	—	9	Normal appearance; poor motion.
27	M	B	—	3	Normal motion and appearance.
28	M	B	—	1	Normal motion and appearance.
29	M	R	—	3½	Normal motion and appearance.
30	M	B	—	2	Normal motion and appearance.
31	M	L	—	1	Normal motion and appearance.
32	M	L	—	1½	Fair result; associated spina bifida occulta.
33	F	B	—	4	Normal appearance; restricted motion.
34	M	R	—	3½	Normal motion and appearance.
35	M	L	—	2	Normal motion and appearance.
36	M	B	—	3	Normal motion and appearance.
37	M	B	—	9	Normal motion and appearance.
38	M	L	—	1	Normal motion and appearance.
39	M	B	—	6	Normal motion and appearance.
40	M	B	—	2	Normal motion and appearance.
41	M	R	—	5	Normal motion and appearance.
42	M	L	—	4	Normal motion and appearance.
43	F	L	—	1	Normal motion and appearance.
44	M	R	—	3	Normal motion and appearance.
45	M	B	—	5	Right, normal; left, slight metatarsus varus persists.
46	M	B	—	1½	Normal appearance; still in plaster.
47	M	R	—	7	Normal appearance; still in plaster.
48	M	L	—	4	Normal motion and appearance.
49	M	R	—	2	Normal motion and appearance.
50	M	L	—	4	Normal motion and appearance.
51	F	L	—	2	Normal appearance; still in plaster.

CONCLUSIONS

In summarizing the results of this operation, we feel it offers many advantages:

1. It allows full correction of the club foot at an early age.

Fig. 3-A

Case 9. Aged three years. Before operation.

Fig. 4-A

Case 13. Aged five and one-half years. Before operation.

Fig. 5-A

Case 28. Aged one year. Before operation.

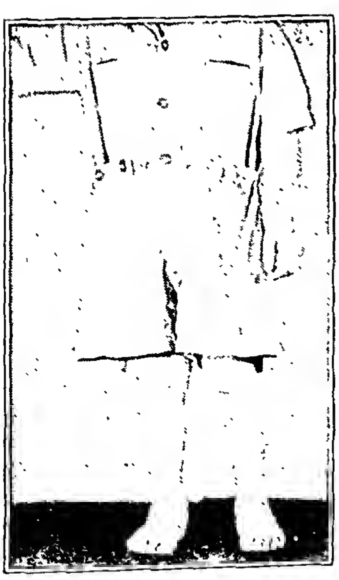

Fig. 3-B

Case 9. After operation.

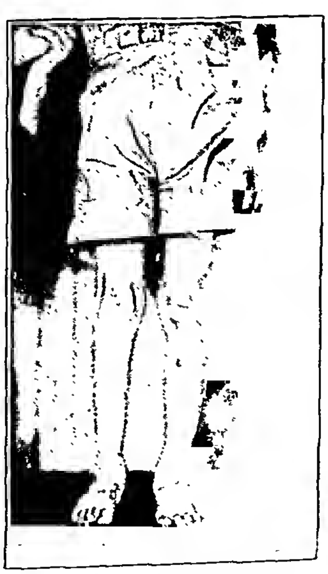

Fig. 4-B

Case 13. After operation.

Fig. 5-B

Case 28. After operation.

2. It is particularly applicable to the resistant and neglected club foot.
3. It leaves the foot with a good range of motion and there is not the stiffness which results from multiple manipulative procedures.
4. It shortens the period of treatment, and avoids the dissatisfaction of parents who tire of the length of time taken by the manipulative procedures and, therefore, neglect the child.
5. In five cases (when braces were not worn nor physiotherapy carried out), there was a recurrence of the deformity and the operation had to be performed a second time; but in all the cases except one the final results were good and the tendency to re-

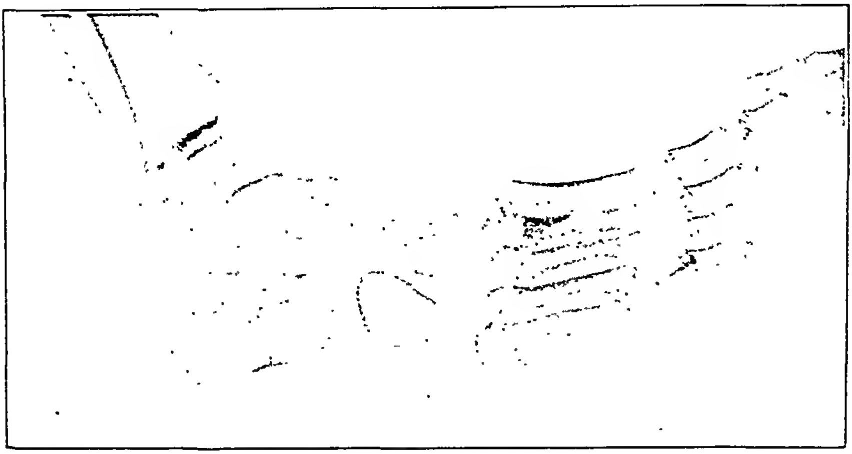

Fig. 6-A
Case 14. Lateral view of right foot before operation.

Fig. 6-B
Case 14. Lateral view of right foot after operation.

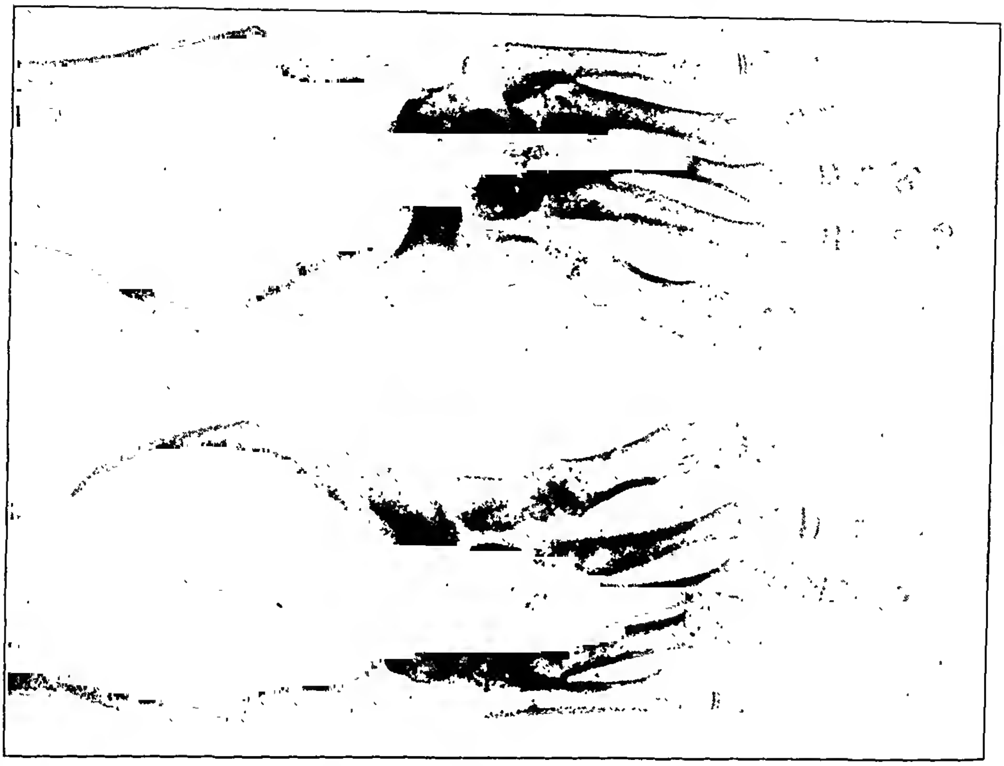

Fig. 7-B
Case 39. Anteroposterior view of the feet after operation.

Fig. 7-A
Case 39. Anteroposterior view of the feet before operation.

FIG. 7-C
Case 39. Lateral view of left foot before operation.

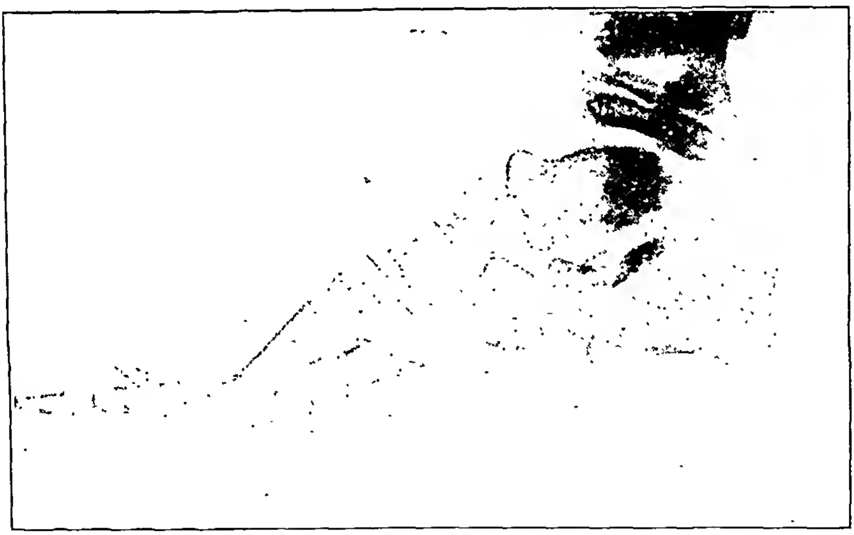

FIG. 7-D
Case 39. Lateral view of left foot after operation.

currence, which is found in the manipulative method, has not been evident.

6. We have found no interference with the growth of the bones operated upon, but checking the growth might be advisable as there would be less tendency to recurrence of the deformity.

The writers express their thanks to Dr. Louis Lamy of Paris who demonstrated this method to Dr. Muro.

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RESULTS OF TREATMENT OF CHRONIC ARTHRITIS AND RHEUMATOID CONDITIONS WITH COLLOIDAL SULPHUR

BY BEN D. SENTURIA, M.D., ST. LOUIS, MISSOURI

From the Arthritis Division of The Aaron Waldheim Health Clinic, The Jewish Hospital, St. Louis, Missouri

Numerous communications [1-14] in the last fifteen years in the European literature report favorable results with parenteral sulphur therapy in chronic arthritis and allied disorders. Of all the preparations in use, Schlesinger [15] prefers the colloidal suspension known as "Sulfur-Diasporal", because of the absence of systemic reaction on intravenous injection and freedom from pain when given into the gluteal muscles.

The present report is based on a study of sixty unselected cases of chronic non-specific arthritis and rheumatoid conditions which were treated in the main only with intravenous and intragluteal injections of colloidal sulphur in the form of "Sulfur-Diasporal" *. No attempt was made to combine with this treatment any other form of therapy, except that, after the effect of the sulphur injections was determined, thirty per cent. of the cases were given a balanced diet containing 1.1 grams of sulphur and 100 grams of carbohydrates.

No foci of infection were removed, no regimen of rest instituted, no vaccines or drugs administered, no correction of postural defects attempted, no increase in vitamin intake advised, nor any physical therapeutic measures resorted to.

As a rule, one intravenous ampule was given twice a week, or one intramuscular ampule weekly. The total number of injections given was 1035, of which 750 were administered intravenously and 285 intragluteally. The average number of injections per patient was 17.3; the minimum, 10; and the maximum, 76. The route employed for medication had no effect on the response. The period of observation of this series was from eight to sixteen months.

Before tabulating the results we must consider the classification of the types used, and the criteria established for determining improvement. The classification adopted by The American Committee for The Control of Rheumatism [16] formed the basis of the divisions used,—namely, Atrophic (Rheumatoid, Chronic Infectious, Proliferative), Hypertrophic (Osteo-arthritis, Degenerative), and Mixed Atrophic and Hypertrophic, in which both of the former types are coexistent. In addition, a fourth

* Sulfur-Diasporal is described by the Doak Company as follows: "Sulfur-Diasporal I.V. (for intravenous use only) is a highly dispersed colloidal sulfur suspended in dextrose. The size of the sulfur particles is from 3 to 5 millimicrons. Each 2-c. c. ampule represents 10 milligrams of colloidal sulfur, when injected into the blood stream.

Sulfur-Diasporal I. G. (for intragluteal use only) is a neutral colloid suspension of sulfur compound (magnesium salt of sulfurated arachic acid) suspended in acid-free olive oil. Size of the particles about 3 millimicrons. Each 2-c. c. ampule represents 20 milligrams of sulfur."

group is included which comprised those cases in which there was no true joint involvement *per se*, but only involvement of the bursae, fasciae, and tendinous attachments about the joints, and referred to by the English authors [17,18] as "Fibrositis". For the standards used to determine improvement, the salient characteristics of the arthritic and rheumatoid states,—namely, pain, impaired mobility, swelling, and deformity—were considered. "Marked", "moderate", and "slight" are employed to designate the corresponding degrees of increase in mobility of the joints, and of diminution in pain, swelling, and deformity. None of the cases were deemed to have retrograded because of the sulphur injections. Whenever there was a question under which class of response a case should be placed, the one less favorable was selected.

Table I summarizes the age limits and average age of the patients; also the minimum, maximum, and average duration of the disease in the various types:

TABLE I

Type of Case	No. of Cases	Age Limits	Average Age	Max. and Min. Duration	Average Duration
Atrophic arthritis	8	29 to 47 years	37 years	6 months to 17 years	6 years
Hypertrophic arthritis	43	26 to 77 years	48.4 years	1 year to 20 years	4.8 years
Mixed atrophic and hypertrophic	4	45 to 60 years	48.5 years	2 to 20 years	10 years
Fibrosi is	5	31 to 70 years	53.4 years	3 months to 2 years	1 year

There were thirteen men and forty-seven women in this series. The preponderance of the hypertrophic type is readily understood when the average age of the whole group is known to be forty-eight, the period of life when this type predominates.

Table II records the results obtained in each class:

TABLE II

Type of Case	No. of Cases	Markedly Improved	Moderately Improved	Slightly Improved	Unimproved
Atrophic arthritis	8	2(25%)	1(12½%)	2(25%)	3(37½%)
Hypertrophic arthritis	43	13(30.2%)	8(18.6%)	10(23.2%)	12(28%)
Mixed atrophic and hypertrophic arthritis	4	2(50%)	1(25%)	1(25%)	None
Fibrositis	5	2(40%)	2(40%)	1(20%)	None
Totals	60	19(31.6%)	12(20%)	14(23.4%)	15(25%)
		$\underbrace{\qquad\qquad\qquad}_{45(75\%)}$			

The following case histories * are given in brief to illustrate the type of case under consideration and the nature of the response:

CASE 1: Atrophic arthritis. A housewife, aged thirty-four, had had progressive involvement of practically all joints, including cervical spine, of eight years' duration. The joints, especially those of the hands, were deformed, thickened, partially ankylosed, and painful. The skin of the hands was shiny and thin; the intrinsic muscles were atrophied. She had failed to respond to removal of various foci of infection, physiotherapy, non-specific and specific vaccines, high-vitamin and low-carbohydrate diet, and various drugs. She had been unable to do her housework for about two years. In November 1932, treatment was started with two intravenous and one intragluteal ampules of colloidal sulphur twice weekly. By January 1933, the joint pains had practically disappeared, motion was restored to a marked degree, and she could perform her household duties. She received in all fifty-eight intravenous injections and eighteen intramuscular injections, this treatment extending over a period of four months. When last seen in August 1933, improvement had persisted.

CASE 2: Hypertrophic arthritis. A truck-driver, aged forty-three, had been unable to work for two years because of constant pain across the lumbar region and radiating down the back of the left leg to the heel. Roentgenograms of his spine disclosed hypertrophic changes on the bodies of the third, fourth, and fifth lumbar vertebrae. A previous regimen of massage and irrigations for a chronic prostatitis, medication, infrared bakings, and a plaster jacket had failed to influence his symptoms. In January 1933, he was started on one intravenous ampule twice weekly. After the fourth injection he was symptom-free. The cast was discarded after the seventh injection. By March 1933, he returned to work and was still employed when last seen in August 1933. He received sixteen injections in all and felt that he did not need any more treatment.

CASE 3: Hypertrophic arthritis. A housewife, aged forty-eight, was seen in August 1932 for attacks of pain in both sacro-iliac joints of over two years' duration. The roentgenograms displayed hypertrophic changes of both sacro-iliac joints. The attacks were occurring every two to four weeks, each lasting about seven days. This patient received one ampule intravenously semiweekly. After the eighth injection she was free of pain and has remained so for over eleven months. She received thirty-eight ampules in all.

CASE 4: Mixed atrophic and hypertrophic arthritis. A housewife, aged forty-nine, gave a history of fleeting pains and stiffness in most of her joints following an attack of pneumonia in 1912. Since 1924, joint changes had developed with increasing pain, stiffness, and disability, so that for the last two years she had been unable to get out of bed, or dress herself without aid; she was unable to do her housework. Since 1925, she had had a tonsillectomy, numerous teeth extracted, an operation on her sinuses, various injections of an unknown nature, physiotherapy, several kinds of diets, and had taken numerous drugs without arresting the relentless progress of the disease. In July, 1932, she was started on one ampule of colloidal sulphur every week, given intragluteally. After the sixth injection, she began to notice a subsidence of pain and an increase in mobility of the joints. Improvement progressed gradually, so that after about two months of treatment, she could get out of bed and dress herself without help, and do some housework. She has attended to her household duties for about one year now. Roentgenograms of her spine and pelvis showed extensive hypertrophic changes on the bodies of all the lumbar and sacral vertebrae, the sacro-iliac joints, the crests of both ilia, and of the right hip. She received forty-one injections in all.

CASE 5: Fibrositis. A grocer, aged fifty-eight, was seen in August 1932, for a

* NOTE: Studies have been made of all the patients in this series, including in each case a thorough history, complete physical examination, roentgenograms of the involved joints, and routine laboratory studies, including uric acid, blood sugar, and basal metabolism determinations.

bilateral subacromial bursitis of nine months' duration. He could abduct his arms only to an angle of about fifteen degrees. His disability had gradually increased in spite of physiotherapy, support, rest, and medication. After the fourth weekly injection of intravenous sulphur, abduction of both arms increased about fifteen degrees. Motion gradually returned, so that by January 1933 practically complete function was restored to the right shoulder, and the left arm could be abducted to an angle of sixty degrees. This improvement was maintained. In June, 1933, another course of the same treatment was instituted. The left arm can now be abducted to an angle of 105 degrees. This patient received a total of thirty injections.

COMMENT

The majority of the patients who were benefited began to show improvement after the third and before the tenth injection. As there were some who did not experience relief until the fifteenth ampule, it was deemed best to establish twenty injections as a course; this number were given before abandoning hope in any particular case. Some received a second course after an interval of one to six months with increasing benefit. The sulphur can be given continuously as long as benefit accrues. Improvement was maintained in the vast majority of cases after cessation of sulphur therapy. In those who did not obtain a favorable result, and who began to retrogress after showing betterment, mechanical factors,—such as obesity, constant trauma, and postural maladjustments—were apparently the basis of the failures. In others the morbid processes were so advanced that the best that could be hoped for was an alleviation of pain.

The prompt and decisive response obtained with the institution of colloidal-sulphur therapy is striking; any other position than that the effect was produced by the sulphur is untenable. The psychic element involved in patients submitted to a new medicament must be considered. Likewise, the optimism engendered by association with fellow-patients who had been definitely improved by the injections played, at the most, an insignificant rôle. Remissions occurred in the diseased states under consideration; but to believe that these took place in forty-five out of sixty cases concomitantly with the onset of the treatment is out of the question. The low-carbohydrate diet too can be dismissed with a word. Only thirty per cent. of the patients were given the diet after the effect of the sulphur therapy had been established; the fifteen who are listed under the failures also followed this diet. In addition, many of the patients had been on such a diet for a long time without any benefit.

CONTRA-INDICATIONS AND UNTOWARD EFFECTS

There are no contra-indications so far as could be determined. Patients with chronic myocarditis, cardiac decompensation, chronic cardiac valvular disease, hypertension, arteriosclerosis, hemiplegia, diabetes mellitus, epilepsy, bronchial asthma, chronic bronchitis, pulmonary emphysema, cirrhosis of the liver, and various endocrinopathies were not adversely influenced by the treatment. No signs or symptoms

suggesting damage to any of the systems developed. Routine urine examinations failed to reveal any change in kidney function.

No general reaction occurred with the intravenous method. However, severe pain was produced at the site of injection whenever any of the suspension escaped into the subcutaneous tissue. As with the intramuscular route, no necrosis, abscess, or slough ever developed. The fluid is apparently completely absorbed when given into the buttocks. Slight discomfort at the site of injection, with a rise in temperature to 100 degrees, occurred at times with the latter method. Recently, Wheeldon and Main [19] have shown by animal experimentation that the dosage employed clinically is well within the limits of safety. The methods approach the ideal type of ambulatory treatment.

CHEMOTHERAPEUTIC ACTION

A review of the literature has revealed significant studies both of the sulphur metabolism in the arthritides and of the effect of sulphur injections. Goldthwait, Painter, and Osgood [20] in 1904 reported two cases of atrophic arthritis in which there was a definite loss of sulphur, and one case of hypertrophic arthritis in which there was a pronounced sulphur retention. Cawadias [21] found an increase in both the total sulphur and unoxidized, or neutral, sulphur in the urine, in cases of atrophic arthritis. He attributes the good results from sulphur injections to the replacement of sulphur lost by these patients. The writer does not concur in this hypothesis, as ten to twenty milligrams a week is hardly sufficient sulphur to balance any loss. Race [22] likewise found in twenty out of forty-two cases of rheumatoid (atrophic) arthritis an increase in the unoxidized sulphur of the twenty-four-hour urine output, and feels that there is a deficient oxidation of sulphur in these cases. McDonagh [23] is of the opinion that colloidal sulphur is of value in all cases in which fibrosis is occurring and has formed, providing the fibrous tissue has not become completely organized.

With a view to ascertaining the physicochemical effects of sulphur injections, Meyer-Bisch and his associates [24] reported that there results an increase in the ethereal sulphates of the blood and synovial fluid, a decrease in the sulphur content of the articular cartilage, and a decrease in the latter's property of swelling when placed in distilled water ("*verminderte Quellbarkeit*"). Schlesinger [15] believes that sulphur compounds play an important part in the oxidation processes of cells, a theory first advanced by Hopkins [25]; and that the introduction of sulphur into the body aids this process. The theory of diminished oxidation in cases of arthritis is in accord with those of Pemberton [26], who states that impaired circulation in the joints, resulting in deficient oxidation or nutrition, might be a prime factor in the arthritic changes; and of Llewellyn [27], who contends that a "subthyroidic state" or "suboxidative state" exists in many arthritics. Kahn and Goodridge [28] are convinced that sulphur metabolism studies "in this field should be fruitful in results to him who will study this condition thoroughly".

CONCLUSIONS

It is felt that empirically, at least, the value of colloidal sulphur in arthritis and allied states has been established. No claim is made that this remedy is a panacea for these morbid conditions, nor is it the purpose of this communication to replace with colloidal sulphur such established measures as removal of foci of infection, rest, diet, vaccines, colonic irrigations, correction of postural defects, physiotherapy, and the indicated medication. The author is fully cognizant of the fact that no single agent or factor can cause the disease; nor can any one therapeutic measure, as a rule, effect a relative cure. In view of the good results obtained, it is believed that colloidal sulphur can be, in many cases, a valuable adjunct to those measures commonly employed in arthritis and allied disorders.

SUMMARY

1. Colloidal sulphur injections were used in sixty unselected cases of arthritis and rheumatoid conditions with improvement in seventy-five per cent. of the series.
2. It is apparently a thoroughly safe remedy and well adapted to routine ambulatory treatment.
3. The mode of action of sulphur parenterally given is not definitely known. The opinion is held that it aids the oxidation processes of cells.
4. Colloidal sulphur deserves a place among the antirheumatic remedies.

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SCIATICA AND THE SACRO-ILIAC JOINT *

BY ALBERT H. FREIBERG, M.D., AND THEODORE H. VINKE, M.D.,
CINCINNATI, OHIO

From the Department of Orthopaedic Surgery, University of Cincinnati Medical School

From the time of the publication by Goldthwait and Osgood, in 1905, of their studies on the sacro-iliac joint, American orthopaedic surgeons have given increasingly great recognition to the relation of sciatic pain to disease of this joint and the sacrolumbar region. They were not the first to point out the possibility of such a relationship. Credit for this would appear to belong to John Hilton. In the United States there is now fairly general acceptance of the view that the great majority of cases of subacute and chronic sciatic pain have their origin in lesions of the lumbar spine, the sacrolumbar and sacro-iliac articulations. Until very recently the chief rôle in producing sciatic pain has been ascribed to the sacro-iliac joint. P. C. Williams has published a study in which he ascribes the cause of sciatic pain to a diminished lumbosacral joint space. The objections to this as a general explanation for this sympton will be mentioned later. In the meantime, to those familiar with the literature of this subject, it cannot have escaped notice that our European colleagues have been singularly silent in respect to this explanation of sciatic pain. Since much is being written continually on this subject, we should have to conclude that there is either a very sceptical attitude concerning the causative rôle of these lesions, if not of their very existence, or else that there is a lack of acquaintance with the fairly profuse literature of the subject. It is indeed somewhat surprising to find that Schanz in discussing this symptom speaks of disease of the bony pelvis as a cause, but only in this indefinite manner. Of those methods of treatment which are applicable to the sacro-iliac and lumbosacral joints, and which have been so successful in American hands, there is no mention.

The explanation for sciatic pain in connection with lesions of the sacro-iliac joint which was originally offered by Goldthwait and Osgood was predicated upon the contiguity of the lumbosacral cord to the anterior aspect of this joint. Inasmuch as anatomical study shows that we may speak only of contiguity and not of contact with it, and since no evidence has been offered of the existence here of pathological infiltrations which would furnish a satisfying explanation of the symptom of sciatica, it is not surprising that the response should have been one of incredulity. The hypothesis was later brought forward that sciatic pain in connection with sacro-iliac lesions is to be regarded as a "referred pain", and similar in this regard to the pain in the region of the knee so often encountered in connection with hip disease. This rests upon the fact that the innerva-

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tion of the sacro-iliac joint is from the lumbosacral plexus. It would appear that this hypothesis is greatly weakened by the well attested fact that in this form of sciatica we almost always find definite and often severe tenderness at the sciatic notch and in the buttock. This is a phenomenon difficult to reconcile with the conception of pain which is merely referred or "sympathetic" in its nature. It has, furthermore, been often observed that, whereas careful immobilization of the pelvic joints has frequently failed to relieve the sciatic pain, prompt relief has most often followed light traction to the extremity, when properly applied.

It should here be noted that all of the considerations dealt with in this communication pertain only to those cases in which the clinical study appears to indicate that the sciatic pain is to be attributed to a lesion of the lumbosacral part of the skeleton. With the differential diagnosis of sciatic pain in general we are not, at present, concerned. It is to be assumed that we bear in mind that sciatic pain may be in the foreground of the clinical picture of spinal tumor situated as high as the level of the tenth thoracic vertebra, for example; furthermore, that a perineuritis of the nerve from metallic or other toxic causes may be assumed to occur upon occasion. It may also be pointed out that upon purely clinical grounds there is reason to believe that very often we may properly speak of pain in the common peroneal nerve rather than in the sciatic nerve itself. Anatomically, it is always easy to separate the peroneal from the tibial part of the sciatic nerve throughout the whole trunk; most often the division takes place at the mid-thigh. The pain in sciatica is most often felt along the posterolateral aspect of the thigh, and the tenderness at the back of the fibular head at the so called Valleix point is strongly suggestive, especially since there is no tenderness along the course of the tibial division where this may be followed. The significance of this observation will be referred to later.

In a recent publication, Williams has sought to show that in the majority of cases of sciatica there is found a narrowing or complete loss of the space between the fifth lumbar vertebra and the sacrum. To this he attributes the sciatica by reason of "motion at the lumbosacral joint plus the constriction of the intervertebral foramen and the arthritic lipping which follows the loss of joint space". There would seem to be much objection to this as an explanation for the generality of cases. That such narrowing is frequently observed is beyond question, and that it is seen in some of the instances in which sciatica is observed is also beyond doubt. However, a number of such roentgenographic findings have been encountered in which no sciatic pain has ever existed. On the other hand, we have thus far encountered no such case in which sciatica and narrowed joint space were found without, at the same time, presenting evidence, in the stereoscopic view of the pelvis, of arthritic change in the sacro-iliac joint of the painful side. When the sciatica is bilateral the changes are, as a rule, to be found in both sacro-iliac joints. If the loss of lumbosacral space of marked degree results in narrowing of the intervertebral foramina, we should expect to find bilateral sciatica as the rule. As a matter

of fact, it is the exception and, when found, should arouse suspicion of possible tumor of the cord. A very few cases have been observed in which marked lateral displacement of the fifth lumbar vertebra on the sacrum resulted in sciatic pain, apparently due to this cause. In a case at present under observation, disorganization of the lumbosacral joint, of chronic infectious origin, has presented the picture of unilateral sciatic pain; associated with it are definite muscular atrophy and evident diminution of both the patellar and Achilles reflexes on the one side only. Pain is always absent in the recumbent position and has been made to disappear by means of an efficient lumbosacral support. We would seem, here, to be dealing with a truly radicular syndrome.

For many years the sacro-iliac joint has been a fascinating subject for study as well as for speculation. If it appears to be vulnerable because it has no direct muscle control, it seems at the same time to be well protected from damage by reason of the wide area of apposed articular surfaces and the exceedingly strong and broad ligamentous bands with which it is provided. For this reason, the concept of primary relaxation of these ligamentous supports, to the degree permitting subluxation to occur, has always seemed to many to be born of need rather than of credible evidence. Corroboration of such displacement by means of roentgenography has not been possible and comparatively few clinicians have been able to satisfy themselves that movement of this joint could be established by careful examination of patients. Excepted from these statements, of course, are the gross displacements resulting from great violence. It has always seemed difficult to explain the sudden occurrence of symptoms ascribable to this joint in persons of great vigor as the result of overexertion, making a misstep, or twisting the trunk while playing golf. Under such circumstances, however, the sacro-iliac complex does present itself repeatedly. On the other hand, it is credible that in a joint having practically no inherent motion in the male, or in either sex under ordinary circumstances, an arthritic process may exist for a long time without producing symptoms. Indeed, with the refinement of roentgenographic technique and the routine use of the stereoscopic films, such processes have become matters of frequent observation either in the absence or the presence of clinical symptoms. That the existence of such an arthritic process could have a relaxing effect upon the ligaments, thus subjecting the joint to abnormal motion with consequent increase of joint irritation and pain, would seem not to be far-fetched, and this has been for many a satisfying explanation. In addition, it must be borne in mind that an arthritis may be long in existence without producing changes visible in the roentgenogram, just as is unquestionably and frequently the case in joints more superficially placed and better adapted for roentgenographic study. However, it happens that in no inconsiderable number of cases, in which this sacro-iliac syndrome presents itself in acute form, there are two considerations which deserve attention. Quite a number of the patients who attribute the sudden onset of sharp pain and disability to some trauma or overexertion can

be made to recall backache or so called "lumbago" attacks of varying severity which they have had more or less recently. In addition, and with or without such history, the careful study of stereoscopic films of the pelvis will often disclose definite evidence of arthritic change in the sacro-iliac joint on one side or both sides.

Unsatisfied with the explanations hitherto advanced for sciatic pain in connection with the sacro-iliac joint, one of us has given thought to this for many years. The most characteristic sign in connection with this joint, as well as for sciatica without reference to its origin, has been spoken of in America, by Goldthwait and Osgood originally, as "straight leg raising", but long before that, however, as "Lasègue's sign". Restriction of the freedom of flexion of the hip joint, with the knee held fully extended by the examiner, together with pain referred to the region of the sacro-iliac joint, has been spoken of in this country as the "sacro-iliac phenomenon" quite apart from the existence of sciatic pain. This has been construed as depending upon the pull made by the hamstrings upon the ischium; after the other side of the pelvis is stabilized in the position of standing, sitting, or lying, movement will occur at the sacro-iliac joint if this be possible. The sensation of pain here is held to be the consequent local reaction, quite apart from the possibility of determining motion by any other means. The search for other possibilities in the way of muscle reactions to motion in the sacro-iliac joint revealed the fact that the pyriformis is the only muscle which may be said to bridge this joint, and that it has a very intimate, anatomical relationship with it. It has also a very close and unique relationship with the sciatic nerve.

Recent search through the literature has revealed the fact that, in 1928, Yeoman published the first reference to the pyriformis muscle in relation to the cause of sciatic pain. He called attention to the fact that the lumbosacral plexus is "separated from it [the sacro-iliac joint] by the pyriformis muscle and its fascia of origin". He furthermore remarked that "Any lesion of the sacro-iliac joint may cause inflammatory reaction of the pyriformis muscle and its fascia".

It will here be of interest to note what anatomists say of the relationships of the pyriformis muscle and the sciatic nerve, quite apart from any considerations of clinical character. The pyriformis arises "from (1) the lateral part of the ventral surface of the second, third, and fourth sacral vertebrae; (2) the posterior border of the great sciatic notch; and (3) the deep surface of the sacro-tuberous (great sacro-sciatic) ligament near the sacrum".[7] Braus declares that "usually the origin of the muscle embraces the joint capsule between sacrum and ilium and extends for a short distance on to the ilium". According to Braus, the pyriformis is the fourth in strength of the external rotators of the hip, coming after the quadratus and obturator internus (cum gemellis). It is relaxed in flexion and outward rotation, a position commonly taken by patients with acute sciatic pain. Most anatomists emphasize the close relationship between the pyriformis and the sciatic nerve. Says Morris: "The relation of the

[sciatic] trunk to the pyriformis muscle is more or less unique. It may pass either above or below the muscle, it may split and pass around the muscle, or the muscle may be split and surround the nerve. Again, there may be a splitting of both the muscle and the nerve, in which case any possible combination of the four parts may occur." In about ten per cent. of all cases, the common peroneal nerve perforates the pyriformis, passing through its substance.

Anatomical study upon the cadaver has substantiated the quotations just given. It has also revealed some additional points of interest and importance. The long head of the biceps is not simply inserted into the tuberosity of the ischium. Its fibers of origin may be followed into the sacrotuberous ligament, with which it is practically continuous. Furthermore, from the sacrotuberous ligament there arises, quite constantly, a definite portion of the pyriformis muscle. On fairly pliable cadavera, the experiment was made of performing the straight-leg-raising test. When the thigh reached approximately twenty-five to fifty degrees of flexion with the trunk, the hand within the pelvis could plainly feel the tightening of the sacrotuberous ligament and of the pyriformis muscle as well. It would seem that we have here the most plausible explanation of Lasègue's sign or the straight-leg-raising phenomenon. Many writers ascribe this to the stretching of the sciatic nerve. In many patients with sciatic pain, the limit of straight leg raising is reached when only a few degrees of hip flexion have been accomplished and long before stretching of the nerve may be spoken of. Wiedhopf believes that the Lasègue phenomenon indicates that we are dealing with disease of the nerve roots. He brings as evidence the fact that sacral anaesthesia causes the Lasègue test to become negative. However, this is precisely what one should expect, since the innervation of the pyriformis is from the first and second sacral nerves and that of the long head of the biceps from the first, second, and third sacral nerves. On the other hand, in eight cases, after anaesthetic blocking of the sciatic nerve trunk, the Lasègue test was still obtainable. Wiedhopf holds that this eliminates the involvement of the trunk as explanation of the Lasègue sign.

Lindstedt believes that the sign of Lasègue indicates a muscular lesion involving most often both the lumbar and the gluteal regions. He holds that the Lasègue manoeuver operates by producing flexion in the region of the sacrolumbar joint. This is in accord with the Albee theory of "myofascitis". It seems likely, indeed, that this may be the explanation of some cases. In our opinion, however, it explains only a portion of them. Even in this case, it seems credible that the pyriformis is the structure of primary importance.

The significance of these anatomical relationships in the present connection lies in the following statements: The pyriformis muscle is the one muscle which may be said to bridge the sacro-iliac joint. A part of its origin is intimately bound up with the capsular investment of the joint and is, therefore, subject to reflex spasm consequent upon intra-articular irritation, just as is observed in other joints. The relationship of the

pyriformis to the sciatic nerve is especially close; particularly is this true of the common peroneal portion. This awakens thought of the possibility of the mechanical effect of pressure upon the nerve as the result of continuous spasm of the muscle. Clinical evidence of such spasm has been found in the presence of limitation of motion in inward rotation of the thigh, if looked for with the patient's hip joints fully extended but not hyperextended. A satisfactory way of making this test is by having the patient lie prone on a hard surface and rotate the thighs by means of the legs flexed at the knees. What is spoken of as "tenderness at the sacro-sciatic notch" is usually found to be a rather diffuse tenderness corresponding to that portion of the belly of the pyriformis which can be affected by pressure through the mass of the gluteus maximus. Pressure upon the superior gluteal nerve should call forth a tenderness much more circumscribed, but which would have to be much nearer the iliac crest than is usually the case. The location of tenderness would appear to correspond much more nearly to the location of the belly of the pyriformis itself.

That the pressure of a muscle belly upon the trunk of the sciatic nerve can be productive of pain and tenderness must be looked upon as unproved at present. As a matter of inductive reasoning it seems unlikely, except as it may represent, in the form of muscle tenderness itself, the result of chronic fatigue or inflammation. It is interesting that Hyrtl attributed such an effect to the "pressure and friction upon the sciatic, produced by the contractions of the quadratus femoris" and "calling forth the unbearable pains caused by any movement of the thigh in rheumatism and inflammatory sciatica". It has been striking to observe that a large branch of the inferior gluteal artery, with its accompanying vein, crosses the sciatic trunk under the belly of the pyriformis.[10] Continuous pressure here from contraction of the pyriformis may conceivably produce a sustained congestion, both in the vein and in the circulation of the nerve sheath. Thus might be explained not only the sciatic pain, but also the tenderness in the pyriformis area. Circulatory disturbance in the nerve sheath would also account for tenderness along the course of the trunk for a variable distance and without assuming that there must exist an inflammatory process of the sheath itself. In performing the Lasègue, or straight-leg-raising, test in cases of acute sciatic pain, one often has the experience that movement is very soon checked by severe pain along the nerve. The pyriformis, as well as the biceps tendon, has part of its origin in the great sacrosciatic ligament and this movement will render the biceps taut. This will effect a direct irritation of an already spastic pyriformis and increase the tension on a previously congested sciatic or its common peroneal portion. While this explanation of sciatic pain in connection with disease of the sacro-iliac joint must be looked upon as speculative and lacking direct proof of its tenability, this is also true of the others which have been offered. On the other hand, it has the advantage of being based on a mechanism having a definite anatomical basis and with substantial clinical and corresponding evidence in hand. Perhaps it is not too much to hope that a more satisfying interpretation

of the symptom of sciatic pain in connection with sacro-iliac disease may have the effect of influencing many who have hitherto been sceptical of the importance of this structure as the most frequent cause of pain.

ANATOMICAL STUDY

The statements made in the body of this paper are supported by studies made in the Departments of Anatomy and Pathology of the

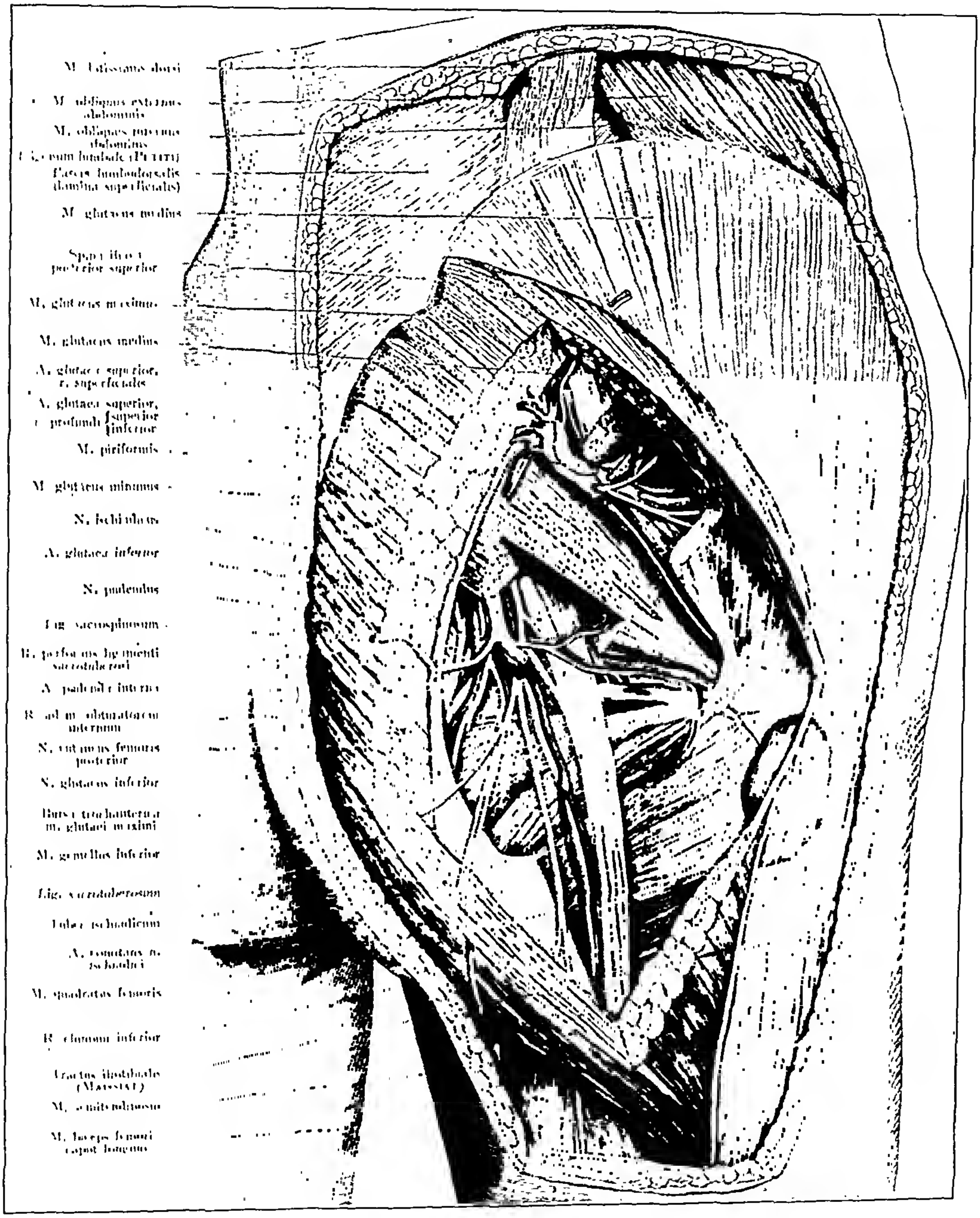

Fig. 1

A portion of the pyriformis muscle has been cut away to show the branch of the inferior gluteal artery and vein lying immediately upon the sciatic trunk. In our dissection this has always been shown to involve a very abundant venous plexus. (From Bardeleben, Haeckel and Frohse.[10]) *(Courtesy of Gustav Fischer.)*

University of Cincinnati College of Medicine. The study consisted of: (1) the dissection of fourteen cadavera with the view of establishing the relations of the sacro-iliac joint to the sacrolumbar plexus and of the sciatic nerve to the pyriformis muscle; (2) a corroboration of the anatomical statements quoted from anatomists in the foregoing discussion.

The plexus lies against the posterior surface of the pelvic cavity, medial and inferior to the sacro-iliac joint. The plexus consists of the trunks and branches of the fourth and fifth lumbar, and the first, second, and third sacral nerve roots. The peroneal division of the sciatic nerve comes from the fourth and fifth lumbar and the first sacral nerve roots. The tibial division of the sciatic nerve rises from the nerves of the fourth and fifth lumbar and the first, second, and third sacral segments. The superior gluteal originates in the fourth and fifth lumbar and the first sacral nerve roots, the obturator and the femoral in the second, third, and fourth lumbar nerve roots. The first and second lumbar nerve trunks may pass over the inferior aspect of the sacro-iliac joint or remain entirely medial to it. The lower three trunks of the plexus in no way come in contact with this joint. There is a very intimate relation of the branches of the plexus with the blood vessels. In fact, they are so closely interwoven that it is difficult to separate them. The many variations that exist in the relationship between the plexus and the vessels are of no practical importance. Intrapelvic origins of the pyriformis muscle are: (1) the roots of the second, third, and fourth sacral vertebrae and from the ilium lateral to the greater sciatic foramen; (2) the capsule of the sacro-iliac joint; (3) the anterior sacrospinous ligament. The muscle passes out of the pelvis from the greater sciatic foramen and additional sources are the pelvic portion of the sacrotuberous ligament, especially the upper part, and the upper margin of the greater sciatic notch of the ilium. The pyriformis muscle forms a rounded tendon which is inserted under the superior and medial aspects of the greater trochanter, and it receives its nerve supply from the first and second sacral nerves. The sciatic nerve passes directly over the pelvic portion of the pyriformis muscle and the two leave the pelvis conjointly. The sacrotuberous ligament occupies the interval between the tuberosity of the ischium and its medial attachment to the posterior aspects of the tubercles of the transverse processes and lateral margins of the third, fourth, and fifth sacral segments, as well as the lateral aspect of the coccygeal segment. The ligament becomes narrower as it approaches the ischium and again expands as it joins the superior aspect of the tuberosity, forming a tendinous union with the attachments of the hamstring muscles. The sacrospinous ligament arises from the lateral margin of the lower portion of the sacrum and the upper coccygeal vertebra. A portion of it fuses with the sacrotuberous ligament, finally becoming attached to the spine of the ischium.

Ten post-mortem examinations were made after the pelvis had been eviscerated. A study of the sacrotuberous ligament and the pyriformis

muscle was made during straight leg raising. The sacrotuberous ligament became definitely taut, after raising the leg twenty-five degrees from the horizontal plane, because of the direct continuity of the sacrotuberous ligaments to the hamstrings at the tuberosity of the ischium. The

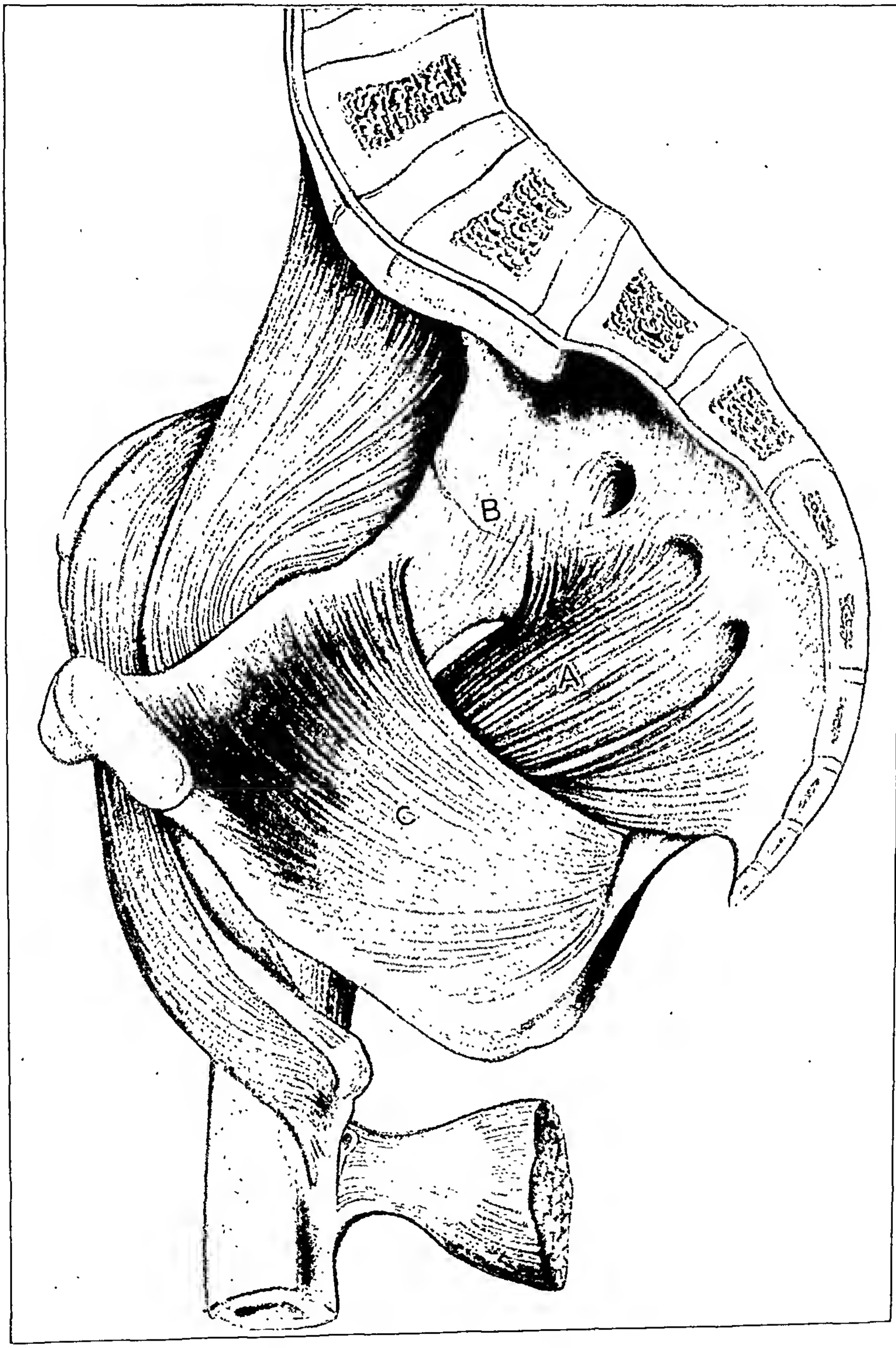

FIG. 2

Modified from Toldt,[9] to show the portion of the fascial origin of the pyriformis which springs from the capsule of the sacro-iliac joint (anterior sacro-iliac ligament). *(Courtesy of Urban und Schwarzenberg.)*

pyriformis muscle was also tightened during this procedure, as well as in the internal rotation of the thigh.

A study of the kinesiology of the pyriformis muscle shows that its

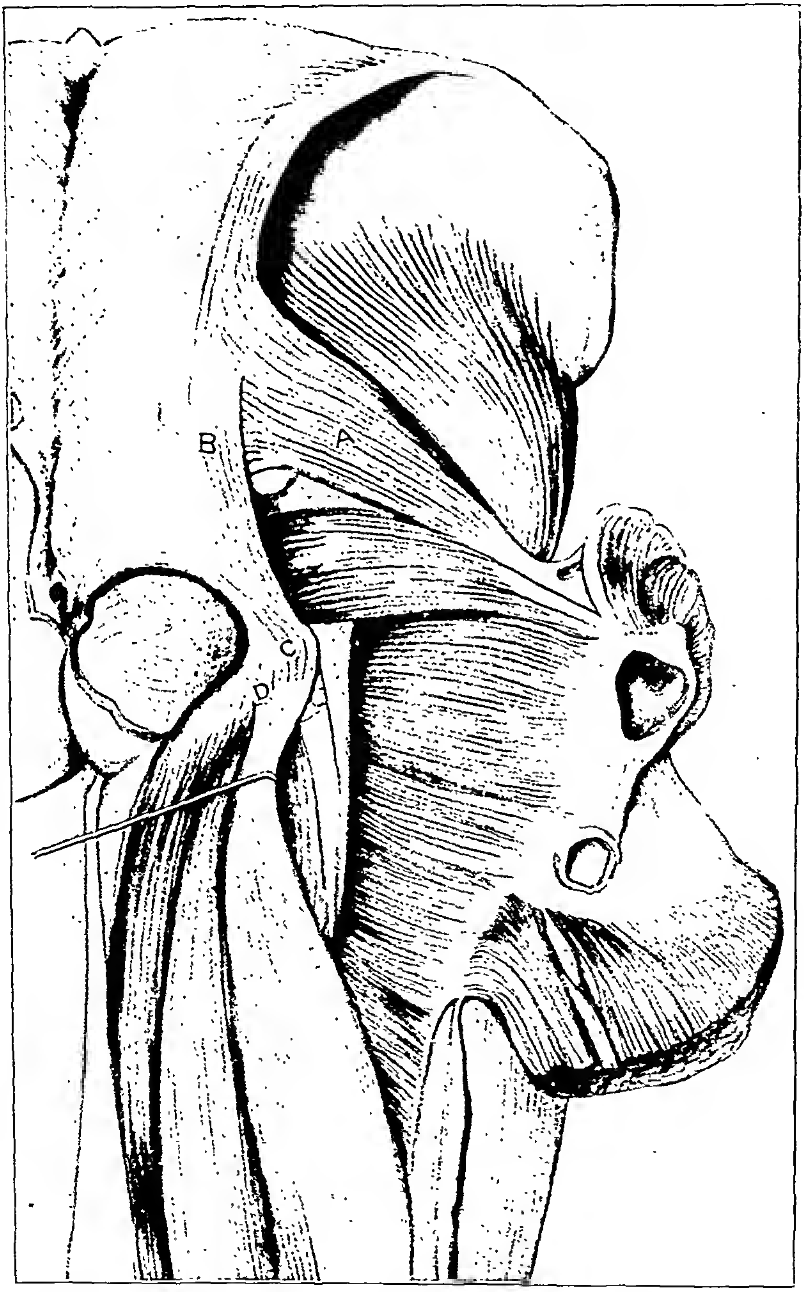

Fig. 3

Modified from Toldt,[9] to show the sacrotuberous ligament *B* and above *B*, the fascial origin of the pyriformis springing from it. At *C* is shown the continuity of fibers from the tendon of the biceps with those of the ligamentum sacrotuberosum. (*Courtesy of Urban und Schwarzenberg.*)

action is changed if its point of insertion is fixed, as in standing. In other words, its point of origin becomes the trochanter and not the pelvis. The action of the pyriformis would be to pull the pelvis forward and elevate the opposite side. It seems possible that a study of this action may furnish the explanation of the scoliotic postures assumed in connection with sciatic pain. This is left for future investigation.

The study of the relationship of the pyriformis muscle and sciatic nerve and of the neurovascular plexus between them is strongly suggestive. It suggests that the relief obtained from manipulative procedures for sciatic pain may have its explanation in the release of adhesions between the pyriformis muscle and the nerve sheath rather than from the stretching of the nerve trunk. Perhaps it may not be going too far to intimate that surgical attack upon the tendon of the pyriformis at its trochanteric attachment might prove to be appropriate in some cases of very obstinate sciatic pain. Naturally, it would be proposed for such cases only as were believed to depend upon the relationship with this muscle.

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CHRONIC OSTEOMYELITIS PRESENTING DISTINCT TUMOR FORMATION SIMULATING CLINICALLY TRUE OSTEOGENIC SARCOMA*

BY GEORGE R. ELLIOTT, M.D., NEW YORK, N. Y.

Recent literature regarding osteomyelitis reveals little but the struggle between the maggot and the microphage. The writer begs to refer the reader to the other side of the picture where, in certain cases, a correct diagnosis holds life, an incorrect diagnosis death.

The late Dr. Starr gave us a picture of acute osteomyelitis developing in the early years of childhood, from two to ten years. This stands today as a classic in surgical literature. With few exceptions, osteomyelitis in early childhood is readily diagnosed. It is in cases later in life that we meet with difficulty in establishing a correct diagnosis. Here again, cases which have not been diagnosed early, but which show sequestra and bone destruction, can readily be dismissed. The most puzzling cases are those in which there is a moderately painful femur or tibia with swelling and little or no temperature or leucocytosis, symptoms not unlike those of several other bone tumors and bone lesions.

Thirty years have done much to give us a better classification of tumors. The work done by the Bone Sarcoma Registry has had much to do with bringing this about. As in osteomyelitis, here also can large fields be eliminated readily,—*i.e.*, those giving a clean-cut history and classical roentgenographic showing. These fields are entirely outside the scope of this paper.

To Dr. Ewing is due the credit of first bringing to the front the term osteogenic, a term now generally used by modern writers, in the Ewing sense, to indicate tumors derived from tissue intended to form bone. Here again, the benign osteogenic tumors are so well known that they, too, can be excluded. The field is, therefore, narrowed down to the malignant osteogenic sarcomata.

Some years ago, when the author was devoting a great deal of time to pathological teaching, he made a collection of sarcomata. These were labeled in accordance with the then accepted classification,—fibro, myxo, chondro, osteoid, small round-cell, large round-cell, spindle-cell, etc. It was taught that each type carried with it a certain difference in prognosis. Practically all of this is now discarded. Very little attention is now given to separate clinical entities. Fibro, myxomatous, cartilaginous, or bony parts have little prognostic significance, since the latter depends upon the activity and quantity of the undifferentiated cellular portions of the tumor. Histologically, these tumors usually show intercellular substance resembling fibrous, cartilaginous, or osteoid tissue, as well as undifferentiated tissue. Usually one or another of these elements predominates,

* Read before the American Orthopaedic Association, Washington, D. C., May 9, 1933.

but, as a rule, all the elements may be found in some part of the tumor. The diagnosis depends upon the examiner and the part of the tumor examined. The perplexing cases are those in which we are dealing with a rather slowly growing sarcoma or with a sclerosing osteomyelitis. Production of bone occurs in both cases.

As an aid to differentiation of the subject which we are considering, the following borderline case is presented.

CASE REPORT

History: An Italian, aged forty-six years, a carpenter by occupation, was seized while

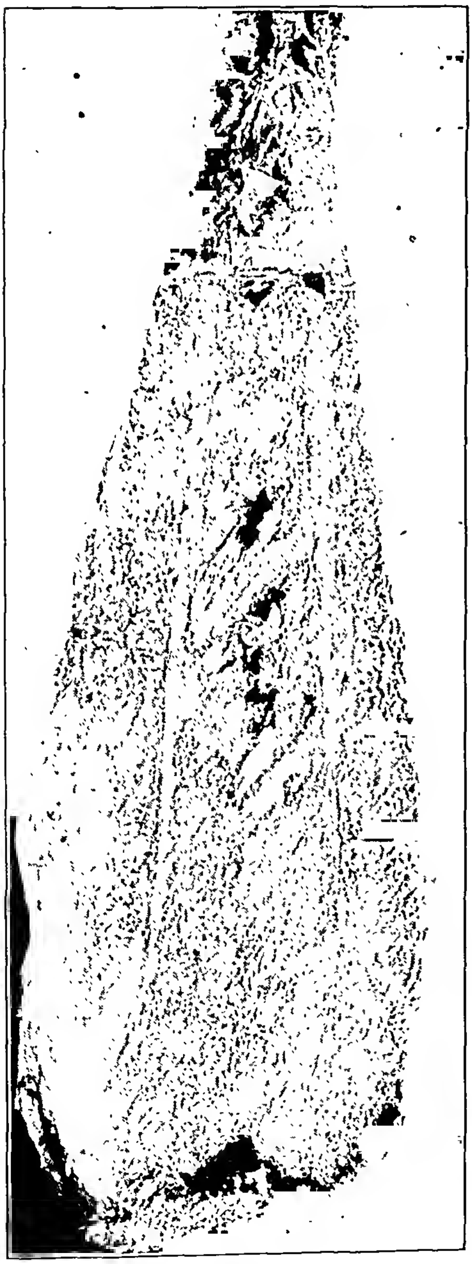

FIG. 1

Cross section of specimen. Lower end of femur.

FIG. 2

Roentgenogram of specimen.

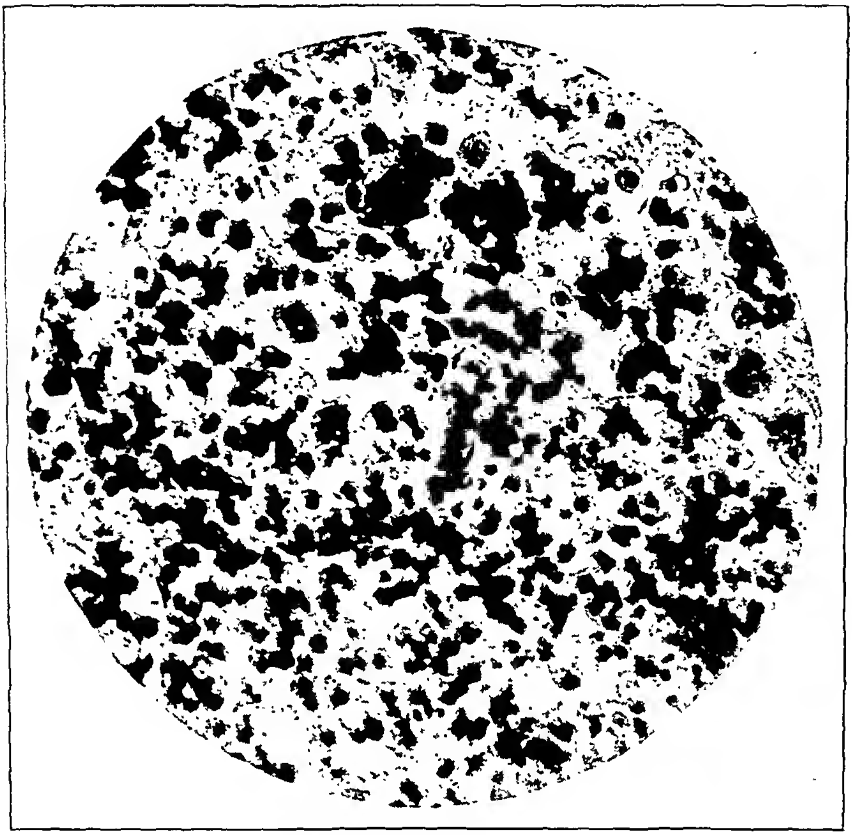

Fig. 3

Photomicrograph, showing tumor formation which is chiefly composed of plasma cells.

at work, without any known injury, with a dull pain at the lower end of the right thigh. The swelling above the knee joint increased and became irregular in contour. Ten days later, the patient was admitted to St. Francis Hospital, New York, Service of Dr. A. H. Harrigan. There was no history of previous typhoid fever. Patient denied ever having had syphilis.

Examination: Wassermann, negative; roentgenographic examination at this time practically negative. Measurements taken eight inches above the lower end of the patella revealed the left thigh to be three inches greater in circumference than the right thigh. There was marked tenderness of the lower part of the thigh, and pressure elicited pain which continued but at no time was paroxysmal.

In an endeavor to make a diagnosis, most of the twenty-two rules of procedure for bone lesions advocated by Dr. Bloodgood[1] were carefully observed. Roentgenograms were taken from time to time. Several of the surgeons who saw these differed in interpretation. At a somewhat later period the roentgenograms revealed a distinct soft shadow, and the clinical symptoms appeared more and more to suggest sarcoma. At this time a biopsy was made. Dr. Nelson, the Pathologist, reported finding a few pus cells. Beyond this, the laboratory findings were unsatisfactory. Amputation was decided upon and performed at the hip joint. Three and one-half years afterward, the patient is living and well.

Figures 1, 2, and 3 are presented to give a clearer understanding of

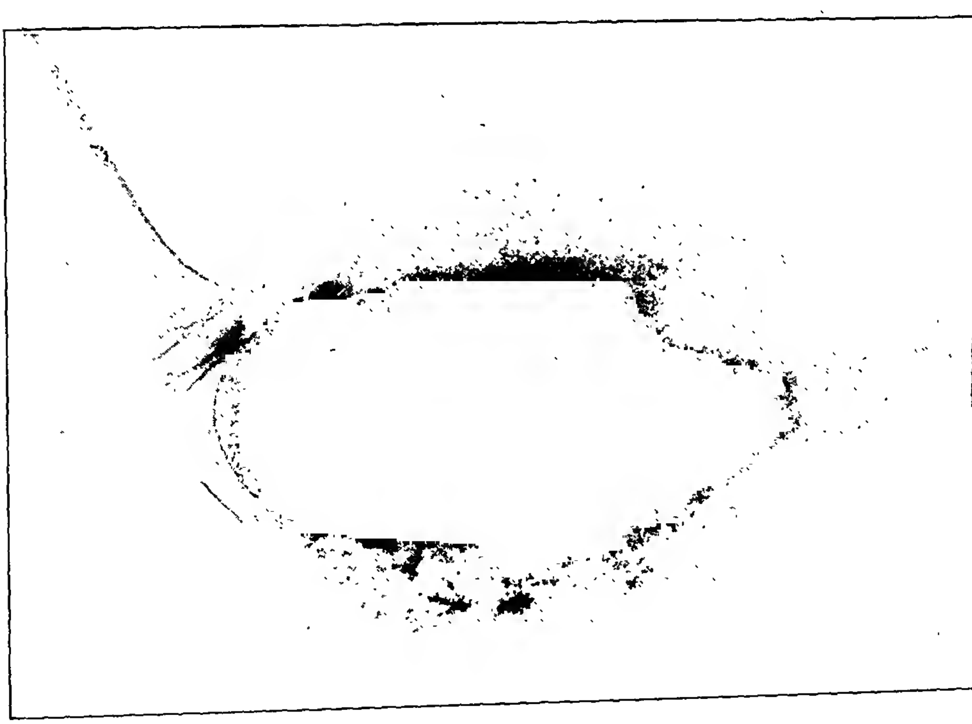

Fig. 4

Roentgenogram of a typical osteogenic sarcoma. (*By courtesy of Memorial Hospital.*)

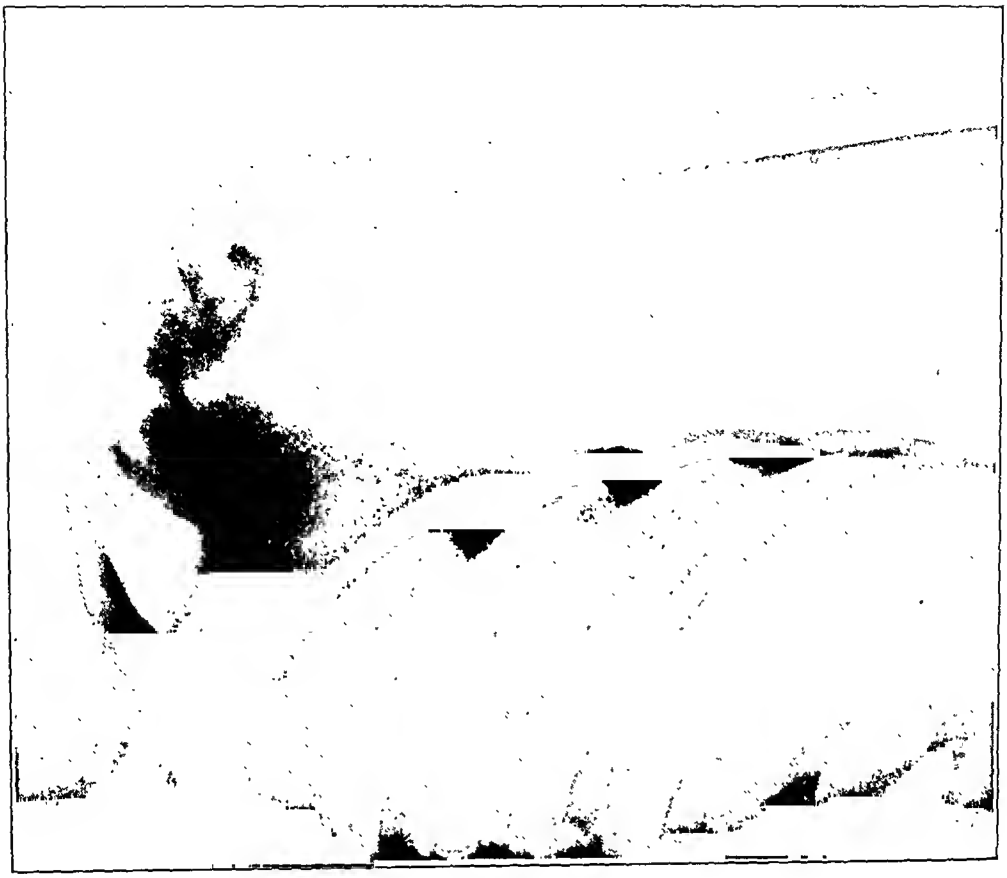

Fig. 5

Roentgenogram of a case of chronic osteomyelitis. Several surgeons made the diagnosis of osteogenic sarcoma. (*By courtesy of Memorial Hospital.*)

the preceding case. Figure 1 shows a cross section of the lower end of the femur, revealing a distinct tumor formation. In Figure 2, the roentgenogram of the specimen, the outline of the bone is visible. Marked evidence of bone destruction in the medullary cavity is seen. Outside the bone cortex there is visible a large mass of soft tissue, apparently semi-organized. Figure 3 is a photomicrograph showing tumor formation. Histologically, this large mass is composed almost entirely of plasma cells, the presence of which speaks strongly for a rather subacute or chronic inflammatory process as its producing factor. It is the belief of most modern workers that these cells are derived from the lymphocyte. They are slightly motile and have phagocytic power. Aside from this minor function of phagocytosis, the importance of the plasma cell in inflammation is unknown [2].

Dr. James Ewing spent considerable time with the writer in studying the gross and microscopic specimens. He was unwilling to make a diagnosis and requested the author to refer the matter to the Bone Sarcoma Registry under the supervision of Dr. E. A. Codman, of Boston. Most of the returns from the Registry favored the diagnosis of chronic osteomyelitis. Dr. Ewing demurred somewhat to this diagnosis and finally sent the following opinion: "Chronic inflammation. Very abundant plasma-cell reaction. The case may throw some light on the origin of plasma-cell myeloma. The gross section is very remarkable."

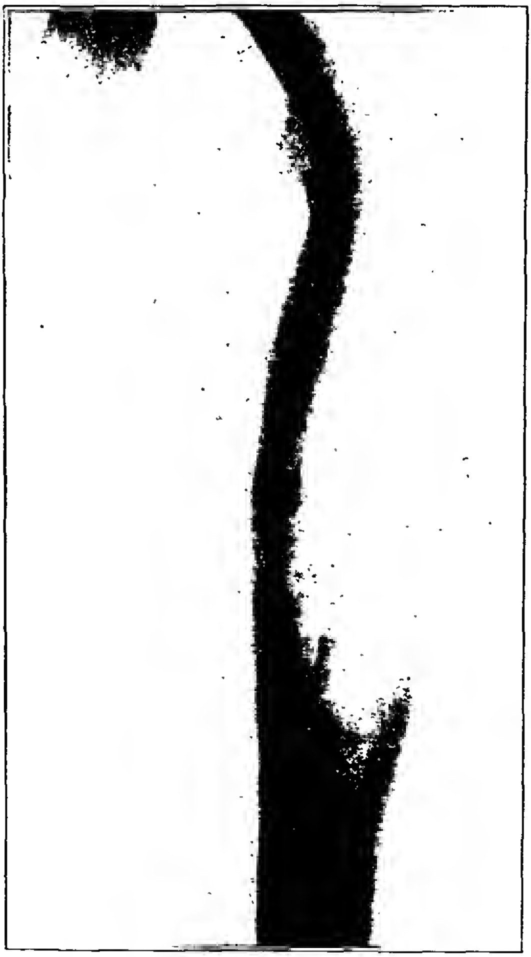

Fig. 6

Ewing's sarcoma (endothelial myeloma). (*By courtesy of Memorial Hospital.*)

DIFFERENTIAL DIAGNOSIS

The following communication was received from Dr. E. A. Codman in response to a request for a few lines pertaining to the

subject of diagnosis to be read to the members of the American Orthopaedic Association. He wrote: "You have hit on one of the most difficult points in the diagnosis of bone tumors. If you should review the Registry collection, you would find that many cases of sarcoma have been mistaken for osteomyelitis. There are still many surgeons who cut first and then diagnose afterwards. Contrary to the general belief, osteomyelitis in adults, who have had no previous infection, is very rare; yet surgeons still continue to cut into bone tumors, thinking that the probability is that the condition is inflammatory. From a pathological point of view the question is a very interesting one."

In a comparatively recent communication regarding the difficulty met with in making a diagnosis, Dr. Bloodgood says: "As my experience grows and more cases of sclerosing and other types of osteomyelitis and the different types of sarcoma in early stages come under my observation, I am finding greater difficulty in making an exact differential diagnosis."

Fig. 7

Garrè's sclerosing osteomyelitis. *(By courtesy of Memorial Hospital.)*

ROENTGENOGRAPHIC CHARACTERISTICS

Following the taking of a very complete clinical history, a good roentgenogram, properly interpreted, stands out as one of the most important aids in making a diagnosis. The roentgenogram alone will often settle the differential diagnosis. A few classical roentgenograms of bone conditions whose atypical forms give the most trouble are shown through the courtesy of the Memorial Hospital, of New York. Two of these cases, even after a biopsy, were difficult to diagnose; the others were diagnosed from the roentgenograms alone. Note the "sun-ray" appearance given by certain types of the sclerosing

form of osteogenic sarcoma (Fig. 4). Yet this is not the most frequent type; according to Geschichter and Copeland [1] it ranks third, with seventy-five cases among a total of 360 osteogenic sarcomata. Again, where the roentgenogram shows the presence of sequelae and bone destruction, with a good clinical history, a diagnosis of osteomyelitis is readily made (Fig. 5).

Figure 6 shows a Ewing's sarcoma (Ewing's endothelioma of the Johns Hopkins School). It must be admitted that right here confusion arises in interpreting the roentgenographic findings in many cases. Frequently, the roentgenographic characteristics do not differ greatly from those of chronic sclerosing osteomyelitis. There is central invasion and bone proliferation in both cases.

It is in the early stages, especially of sclerosing osteomyelitis of the Garrè type, that diagnostic difficulty arises. It is generally agreed that sclerosing sarcoma cannot be differentiated from the Garrè type of sclerosing osteomyelitis by means of the roentgenogram alone. The roentgenographic appearance of the latter frequently bears a close resemblance to that of Ewing's sarcoma. In both there is a widening of the shaft by stimulation in the periosteal and cortical zones. The medullary cavity becomes narrowed or obliterated, while the cortex is thickened and the density much increased. The clinical history may help us here. The clinical history is the reverse of that presented by Ewing's sarcoma. The latter begins mildly, but rapidly produces acute symptoms. Garrè's sclerosing osteomyelitis begins acutely, but rapidly becomes chronic, extending over a period of years, with ossification much more pronounced. (See Figure 7.)

Confronted, then, with the large number of bone lesions giving similar roentgenographic pictures, which the expert roentgenologists find impossible to differentiate, we are finally driven to a biopsy.

BIOPSY

In dealing with bone tumors, "Avoid biopsy if possible" is the universal slogan of those having had a large experience.

But what is the preferable method of procedure?

At the Memorial Hospital of New York the "aspiration method" is commonly practised. Dr. Ewing, strongly opposed to any form of biopsy in dealing with bone tumors if it can possibly be avoided, prefers this method. The following technique is carried out: An eighteen-gauge needle is used and a twenty-cubic-centimeter syringe. The needle is inserted into the tumor and a plug of tumor material is withdrawn into the needle. A smear is made and stained.

If this method fails, in certain cases the so called "punch method" is used. There are several "punch methods" in use. The one preferred at the Memorial Hospital is that of Dr. William J. Hoffman, Clinical Fellow in Cancer Research.[3] He has furnished the writer with the following personal communication: "I have found this biopsy punch and

technique of great value in the diagnosis of suspected bone tumors. By this means an actual specimen of tissue is obtained from which paraffin sections can be cut in the usual way. The histological diagnosis thus afforded enables one to differentiate between certain bone conditions which clinically and radiologically often are indistinguishable, such as endothelial myeloma and osteomyelitis, chronic osteitis and osteogenic sarcoma."

SUMMARY

Running through the following diagnostic gamut of bone lesions, a correct diagnosis is usually made:

1. A well taken clinical history.
2. Good roentgenograms, correctly interpreted.
3. As a last resort, a biopsy made with proper care.

Exceptions do occur, as proved by the case reported in which, after the use of all these methods and with the gross and microscopic specimens available, doubt still existed as to the correct diagnosis.

It may prove that in this case we have unearthed a real entity, or, at least, a very atypical form of a classical bone lesion. In support of this the writer reports the following recent interview with Dr. James Ewing who again reviewed the specimens.

Dr. Ewing recalled his first study of the gross and microscopic specimens some three years ago and said that he had often thought of what at that time appeared to him an unusual case. He stated further that it still appeared to him to be unique, a diseased condition which, to his knowledge, had never been described. He could conceive of a finding like the above arising from a bone infection of low grade and leading to abundant plasma-cell reaction, the plasma-cell formation finally predominating as the infection subsided and leading to a condition not unlike that of the specimen. To this might be given the name "osteomyelitic plasma-cell myeloma".

The author wishes to acknowledge the valuable assistance given to him by Dr. Ralph Eugene Herendeen, Roentgenologist of Memorial Hospital, New York, and by Dr. R. S. Nelson, Pathologist of St. Francis Hospital, New York.

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A STUDY OF ONE HUNDRED CASES OF SUBDELTOID BURSITIS *

BY MARK H. ROGERS, M.D., BOSTON, MASSACHUSETTS

Since Codman's original paper on "Stiff and Painful Shoulders" in 1906[1], there has been a constantly growing number of papers on this subject, many of them in regard to individual treatment of certain phases of the condition. The object of this paper is to analyze a definite number of cases of subdeltoid bursitis in order to find out whether there is any clinical entity, whether they can be classified, and whether there is a definite relation to trauma or infection. Codman was one of the first to study the anatomy of the shoulder joint and the relation of the subdeltoid bursa to stiff and painful shoulders. He called attention to the anatomy and function of the supraspinatus tendon and its relation to the joint capsule and the bursa[2].

In this study the author has omitted all cases of distinct chronic infectious arthritis, with involvement of many joints, and also of stiff shoulders resulting from fractures about the joint.

Dickson of Cleveland has recently analyzed two hundred cases, designating these as cases of "periarthritis of the shoulder joint". He states that this is a broad term, but that he is not willing to narrow the pathology to a limited area. He does emphasize the degree of disability, the length of time required in his series for treatment, and the importance of this subject. There is no question that the amount of disability is great, that the pain element alone is considerable, and that there may be difficulties in obtaining complete restoration of function of the shoulder joint.

There are certain anatomical facts that should be appreciated in order to understand the known pathology of subdeltoid bursitis. The capsule of the joint extends from the edges of the glenoid cavity and surrounds the head of the humerus. The supraspinatus muscle arises from the scapula and is attached to the humerus in the same area as the capsule of the joint. It spreads out and becomes a part of the joint capsule on the superior surface of the humerus just above the joint capsule and beneath the floor of the subdeltoid bursa, which is a thin-walled structure lying just beneath the deltoid muscle. On separating the fibers of the deltoid, one first meets the bursa, then the supraspinatus, and finally the joint capsule.

There are certain well established clinical facts that should also be stated. In this condition, abduction and internal and external rotation of the shoulder joint are restricted. Flexion and extension of the shoulder joint are not restricted as is the case in a true arthritic or tuberculous process involving the joint. The pathological condition that limits abduction

* Presented at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 9, 1933.

and rotation is in the region of the bursa and the supraspinatus tendon at its conjunction with the capsule and the attachment of the capsule to the humerus. The articular surfaces of the head of the humerus and the glenoid, being true joint surfaces, are not involved.

The author's conception of what happens when there is trauma to this area is based on what is found in grosser injuries that have been seen at operation. It is known that, when there is a rupture of the supraspinatus tendon, the beginning of this tear is at the attachment of the joint capsule and spread-out tendon to the humerus, so that in early cases one finds that the joint space is open. This same process takes place in a lesser degree in a good many cases of trauma, and, therefore, it is easy to see why the protecting bursa is necessarily involved, as it is absolutely contiguous, and may be torn.

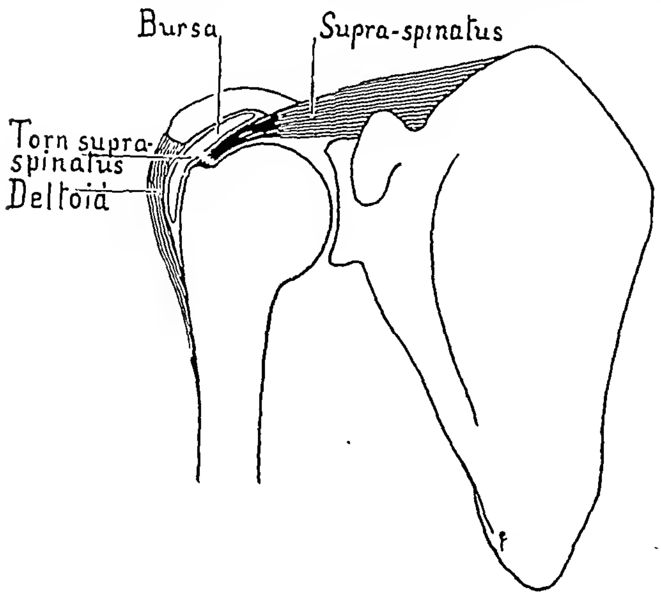

FIG. 1
Diagrammatic drawing to illustrate the tear of the capsule and the supraspinatus and its relation to the bursa.

It is a known fact that the so called calcified areas shown by the x-ray in acute and sometimes in chronic cases of so called bursitis are anatomically situated on the superior surface of the joint capsule and supraspinatus tendon. They are not within the bursal sac, but the posterior wall of the bursa lies on top of the deposit. Sufficient work has been done in the analysis of this substance to prove that it is essentially a calcium carbonate. In an acute case it is a thick, whitish substance, that can be handled like thick purulent material. The reason for this accumulation of a calcium salt in this area has not been satisfactorily explained.

Clinically, these cases are grouped into three classes: (1) the acute, fulminating type; (2) the chronic, adhesive type; and (3) the traumatic type. The acute type comes on without any history of injury or infection and is very acute in onset, reaching its maximum intensity in three or four days. The region of the bursa is tender to the touch. In this group the shadow of calcification is usually found by x-ray.

The chronic, adhesive type comes on slowly, and at the end of a month there is an absolute loss of abduction, but no acute pain unless the arm is moved. This presents an entirely different clinical picture from the first group.

The traumatic type follows a distinct history of a fall or a twist of the arm.

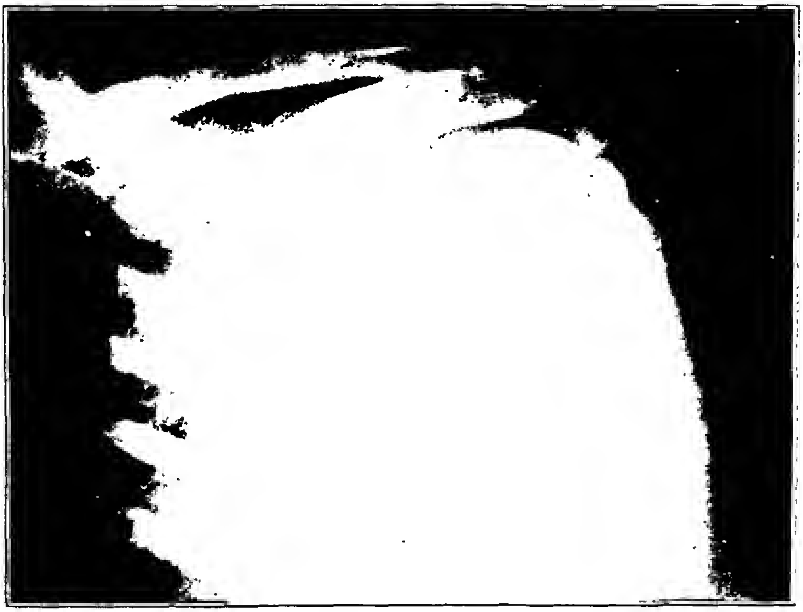

FIG. 2
Roentgenogram of Case 1, showing shadow of calcium carbonate.

There were twenty-nine cases classified as of the acute, fulminating type. In this group, the onset was fairly acute, often reaching its maxi-

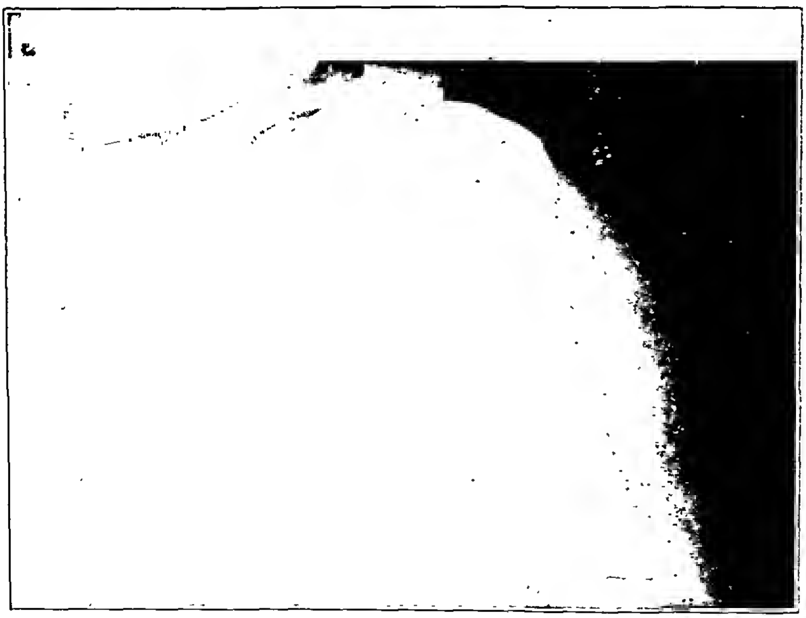

FIG. 3
Roentgenogram of Case 1, taken six weeks later, showing disappearance of shadow.

mum of pain within two or three days. The chronic, adhesive group comprised forty-six cases, in which there was a slow onset and gradual loss of abduction and rotation, two months sometimes being required to develop the maximum loss of motion. There were twenty-five cases that had a definite history of injury or strain, sometimes moderately severe but more often slight, but later developing a gradual loss of motion, which could not be distinguished from the results in the first two groups.

The statistics as regards the average ages of the patients studied are of interest. The average age of Group I was forty-eight years; that of Group II, fifty-six years; and of Group III, fifty-five years. This seems to

TABLE I

ANALYSIS OF 100 CASES OF SUBDELTOID BURSITIS

Type of Case	No. of Cases	Average Ages of Patients	No. of Patients between Ages of Thirty and Forty
Acute Fulminating	29	48 years	9
Chronic Adhesive	46	56 years	2
Traumatic	25	55 years	1

be a fairly level average, but in Group I there were nine patients between the ages of thirty and forty, while in Groups II and III there were but two patients and one patient respectively in this age period. In this series there is no record of any case in which the patient was under thirty years of age, showing that this is not a condition common to youth.

The next question of interest is the relation of focal infection. There has been a good deal of emphasis placed on the finding of a focus of infection in all three classes. The first and second classes would be most likely to show this relationship. In the acute, fulminating type the acute calcification, as shown by the shadow in the x-ray, is most likely to be seen. There is no clinical evidence that this follows acute infectious processes. The known chemical analysis of this substance does not suggest that this is the result of an infection.

In Group II, where one might expect to find evidence of focal infection, the records do not show such evidence. This does not mean that no case showed imperfect teeth, etc., but no evidence in the history can be discovered to warrant the finding of a connection between the shoulder and a focus of infection. Therefore, the author is not at all convinced that the condition dealt with is allied to the infectious arthritides.

Of the forty-six cases of the adhesive type in Group II, eighteen were diabetic. The author has long been aware that this condition is fairly common among diabetics, coming on insidiously and accompanied by almost complete loss of abduction. There may be a fallacy in these figures, because for some time the writer has been seeing joint lesions from a large diabetic clinic, and this may account for these figures. At the same time, there is a larger percentage of cases of subdeltoid bursitis in diabetics than in Group I and Group III.

The author is unable to explain this proportion of cases among diabetics except that it may possibly have something to do with the age of this group and that diabetes is apt to make tissues older, as is shown by the fact of early arteriosclerosis and changes in the blood vessels. The figures given tend to show that a degenerative process rather than an infectious process is involved.

The next question to be discussed is what is meant by recurrence of attacks of acute pain and symptoms. The writer has records of a few cases in which the patients developed typical adhesive bursitis in one shoulder one year and in the opposite shoulder the next year. But what is commonly called a recurrence of symptoms occurs in those cases that have made only a partial recovery of function, in that some abduction and internal rotation has not been fully regained, although the individual may have been satisfied that he had recovered his motions, chiefly because there was no pain. It is a common belief that some extra exertion brings on a recurrence of symptoms. The explanation of this lies in the fact that there never has been a complete return of motion and some slight trauma causes a tear of the adhesions. Then, in the traumatic group, there is a definite thickening at the attachment of the capsule and certain motions, especially external rotation, bring on a so called catch. All patients learn how to use the shoulder with this limitation, avoiding the motion that causes the catch. The point to be emphasized is that, unless a complete restoration of function is brought about, there is a distinct liability to recurrence of symptoms.

CONCLUSIONS

In analyzing this series of cases there are certain factors that stand out:

1. There are three different types of cases classified under subdeltoid bursitis.
2. It is not a condition of youth, but of middle and old age. There are no cases in which the patients were under thirty years of age, and the only group in which there is an appreciable number of patients between the ages of thirty and forty is the acute fulminating type.
3. There is no evidence that there is an element of focal infection, as is so commonly thought. Therefore, the term periarthritis is misleading.
4. In order to prevent the long-drawn-out treatment that is sometimes necessary in these cases, one should have a clear picture in mind as to what is going on and what the results should be. Much of the treatment that is not logical or necessary could then be prevented.

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A SIMPLE METHOD OF TREATMENT OF COMMON METATARSAL DISABILITIES*

BY J. TORRANCE RUGH, M.D., PHILADELPHIA, PENNSYLVANIA

Loss of the metatarsal arch is a very common condition and its treatment is very frequently left to the care of the shoe clerk and the venders of all kinds of pads and supports. There are two types: (a) relaxed or atonic, and (b) contracted or hypertonic. The only symptoms common to both are pain and disability, but the signs are quite different. The relaxed form occurs much less frequently and, because of the lack of tone in the supporting tissues, requires appropriate support for its relief. The contracted type occurs mostly in adults and is primarily due to faulty footwear (short shoes with high heels).

There may be a previous history of longitudinal arch disturbance or muscle weakness, strain, injury, heredity, constitutional disease, or dyscrasia; and any of these factors will render the ill effects of foot-covering much more certain. Occupation and long hours of standing are also causative and body weight is an important factor. A typical case is as follows:

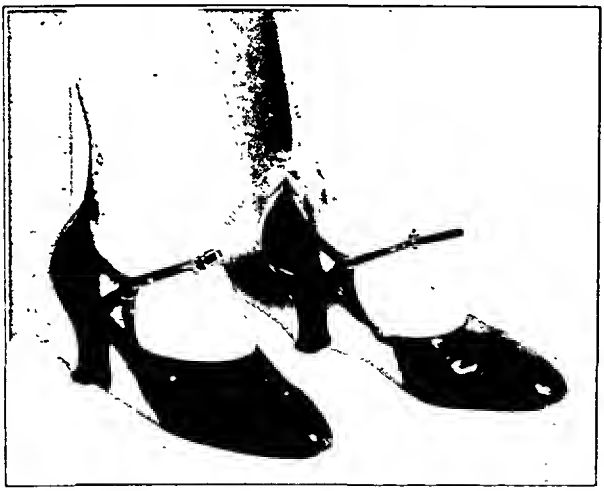

FIG. 1

Type of shoe which causes dorsal dislocation of the toes. Shoe short and heels too high.

Miss M. B., aged thirty-five years, a school teacher, was scarcely able to continue at her work because of pain in the front part of her feet. She was fairly stout and had worn the ordinary short shoes with heels one and three-fourth inches high and had tried many varieties of shoes, plates, exercises, massage, etc., but without relief. Her station was good, but the balls of the feet rested forward of the seat of the shoe; the great toe joint was well forward of the turn of the shoe sole, and her long toes contacted the toe of the shoe. The outer four toes were contracted and curled over against the foot and on top of the metatarsal heads. When standing barefooted, the outer four toes turned directly downward, the ends resting on the floor (Fig. 2), and, when straightened, could not be dorsiflexed with the fingers. Corns on top of the toes and calluses under the metatarsal heads were painful, as were also the pads of fat in front of the calluses.

* Read at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 9, 1933.

When the foot was raised and pressure was made against the ball of the foot to bring the foot to a right angle with the leg, the toes were drawn to strong plantar flexion, the dorsal flexors were relaxed, and the straightened toes could not be dorsiflexed (Fig. 3). This is the determining sign which reveals flexor shortening and shows the heads of the metatarsals extremely prominent beneath the sole. The diagnosis of the case was loss of the metatarsal arch, dorsal dislocation of the outer four toes, and contraction of the plantar flexor muscles.

The patient was advised to have these plantar tendons cut, and to secure shoes long enough, with a heel not more than one inch high, and with a firm shank; and, because of her previous failures, she accepted the advice.

Under gas anaesthesia, the plantar-flexor tendons were cut with a long-shanked, narrow-bladed, sharp tenotome. The foot was held by an assistant making pressure against the ball. The little toe was first pulled straight, the tenotome inserted on the outer side of the base of the toe and the tendon cut (Fig. 4). The blade was then pushed forward and the tendons of the fourth, third, and second toes cut in the same manner. The tenotome was then withdrawn and pressure made with a pledget of gauze over the puncture to control the bleeding (Fig. 5). The other foot was similarly treated, the anaesthetic was withdrawn, and in about two minutes the bleeding ceased. It was now possible to dorsiflex the toes when they were held straight with the fingers; and when the patient stood barefooted, the toes lay out straight (Fig. 6). A small dressing was held in place with adhesive plaster and the stockings and shoes were put on.

After a few minutes' rest, she was sent home and advised to continue walking about. In three days, the dressing was removed, the feet soaked daily in hot water, and the toes drawn strongly by the fingers into dorsal flexion to prevent recontraction. Proper shoes of sufficient length were fitted to the feet. In a month or six weeks the corns had disappeared and later the calluses also; and the feet functioned painlessly.

When the shoe is short, the toes are dorsally dislocated and the vamp of the shoe, pressing strongly on the tops of the toes, depresses the metatarsal arch and thus causes the major part of the pain and discomfort. When, however, the shoe is long enough, and the heels are low, and the plantar flexors have been cut, the toes extend forward, the distal ends rest on the shoe sole and the dorsal flexors then act as a suspension cable to assist in raising the metatarsal arch. If moderate arthritic changes are present in the toes, the toes can be forcibly straightened and, by thorough follow-up manipulation, the contractures can be overcome and the toes kept straight.

Fig. 2

Toes contracted and in dorsal dislocation.

We have now employed this method of correction of these cases for about ten years and have succeeded in every case where the patient has continued to wear proper stockings and shoes and to stretch the toes forward each day.

We have also used this same plan of treatment in three cases of Morton's

Fig. 3

Inability to bend toes dorsally when held straight with fingers.

Fig. 4

Section of plantar flexors through one puncture with the tenotome.

Fig. 5

Toes are easily dorsiflexed when held straight with the fingers.

Fig. 6

Toes straight on right foot. Voluntarily dorsiflexed on left foot.

toe with complete relief from the disability. In the first case, the trouble was of twenty years' standing and section of the plantar flexors of the fourth toe resulted in a complete cure. In another case, that of a physician, it was necessary to cut the tendons of the fourth and fifth toes and a long-standing trouble was cured. We have gotten away almost completely from the use of metatarsal pads by this simple procedure and have not had a single complication in a large series of cases so treated. The operation is commonly done in the office of a dentist who is a very skilful anaesthetist and it has not been necessary to hospitalize any patient.

CONCLUSIONS

1. Loss of the metatarsal arch is a common condition.
2. Its most frequent cause is high-heeled and short shoes.
3. Dorsal dislocation of the toes with plantar flexion is maintained by contraction of the plantar-flexor muscles.
4. The test for contraction is inability to dorsiflex the straightened toes with the fingers when the foot is held at right angles to the leg, by upward pressure on the ball of the foot.
5. Section of the plantar flexors relieves the flexion and dislocation, does not incapacitate the patient, and, when proper shoes are worn, gets rid of the corns and calluses.
6. The same treatment has corrected three cases of Morton's toe.

A NEW METHOD OF OSTEOTOMY FOR THE CORRECTION OF LONG STANDING BONY DEFORMITY AT THE KNEE *

BY ARMITAGE WHITMAN, M.D., NEW YORK, N. Y.

Hospital for the Ruptured and Crippled, New York

Experienced orthopaedic surgeons are familiar with the difficulties and dangers attendant upon the correction of deformities of long standing. Along with the ligaments and muscles, the blood vessels and nerves become so contracted that too sudden or too radical correction of the deformity may lead to the gravest consequences. In deformities affecting only the soft parts, these dangers may be avoided by a succession of operations or by gradual wedging of the corrective plaster.

The two cases here reported showed solid bony ankylosis of the knee joint, with the tibia fused at a right angle to the femur. The first patient was a child of eleven with the ankylosis of four years' standing; the second, a man of fifty-five with the deformity of forty years' duration. Removal of a bony wedge sufficient to correct the angulation would have caused great shortening of the limb, as well as running grave risks of compromising the circulation.

I had recently been interested in the problem of lengthening short limbs, and it occurred to me that the same principle—gradual alteration of the structure of bone—was here properly applicable.

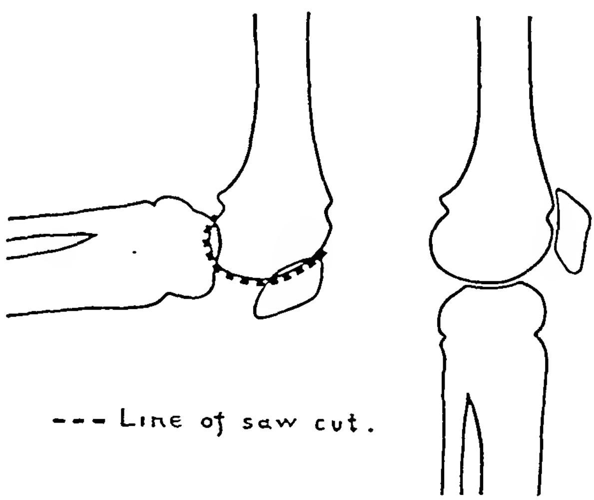

FIG. 1

Diagram showing right-angle contraction and line of the semicircular saw cut.

CASE 1. M. O'N., aged eleven, had suffered from pyogenic arthritis, following injury four years before. He was admitted July 3, 1931, with right-angle flexion deformity of the left knee and solid bony ankylosis. There were scars on the inner and outer aspect of the knee, below and internal to the patella, on the inner aspect of the calf and popliteal space, and over the greater trochanter.

Operation, July 6, 1931:—Two three-inch incisions curving downward were made

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lateral to the patella. The upper surface of the femur was exposed and the periosteum stripped back. A Gigli saw was then passed across the bone, subperiosteally, the patella sawed through its attachment to the femur, and the saw passed curving downward and backward in such a manner as to approximate the original outline of the femoral condyles. The flexion deformity was then easily reduced to an angle of 135 degrees. A plaster spica was applied.

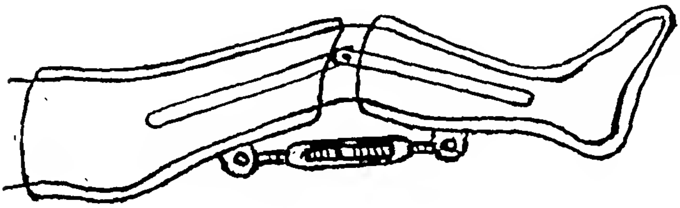

Fig. 2

Gradual correction of the flexion deformity by hinge plaster and turnbuckle.

From July 8 to July 15, the plaster was wedged.

Manipulation, July 15:—Correction to 170 degrees. Roentgenogram taken after manipulation showed full correction.

July 23:—Patient began weight-bearing in plaster and was discharged on the following day.

The patient is now walking without apparatus, his leg fully extended on the thigh.

Case 2. R. C., aged fifty-five, was admitted September 14, 1932, with flexion deformity of the left knee of 90 degrees, solid bony union. Patient had been injured forty years previously. The deformity had developed after hospitalization for that injury.

Operation, September 15, 1932:—Two sickle-shaped incisions, with the convexity upward, were made on the internal and external aspects of the knee joint. The bone was exposed and the periosteum elevated. A butcher (scroll) saw was then introduced through the two incisions and the bone sawed through at approximately the site of the joint line, the saw following approximately the original outline of the lower extremity of

Fig. 3

Case 1. M. O'N. Before operation.

Fig. 4

Case 1. M. O'N. After operation.

the femur. The tissues were then sutured with considerable difficulty since there was a good deal of bleeding from the bone which could not be controlled. The deformity was corrected to an angle of 135 degrees without interfering with the circulation of the foot. Both the dorsalis pedis and posterior tibial arteries could be palpated. The plaster was then applied with the idea of further correction of the deformity by means of a turnbuckle.

Fig. 5
Case 2. R. C. Before operation.

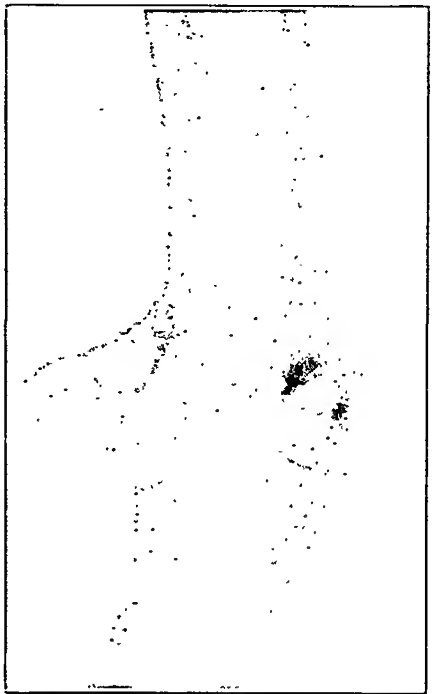

Fig. 6
Case 2. R. C. After operation.

September 22, 1932:—Deformity was somewhat further corrected by the turnbuckle.

September 27, 1932:—Stretching under anaesthesia; about 10 degrees' gain. A spica was applied.

October 1, 1932:—The turnbuckle was reapplied.

October 6, 1932:—Roentgenogram showed correction to 155 degrees.

October 10, 1932:—Stretching under anaesthesia to 160 degrees. A spica was applied.

October 14, 1932:—Patient was discharged in the spica.

November 29, 1932:—He was readmitted. The plaster was removed.

December 3, 1932:—A walking plaster was applied from groin to ankle.

December 14, 1932:—He was discharged.

This patient (Case 2) has since been shown before the Alumni of the Hospital for the Ruptured and Crippled. His knee is ankylosed at an angle of 160 degrees, which enables him, with a high heel in an ordinary shoe, to walk without apparatus,—the first time in forty years that he has had his foot upon the ground.

I feel that in this case the deformity might have been fully corrected had the posteriorly projecting portion of the tibia, as shown in Figure 6, been removed. It was probably its pressure upon the popliteal vessels that interrupted the circulation. However, the extremity was

converted from a useless to a weight-bearing one, which gave its owner satisfaction.

In 1923 (Observations on the Correction of Deformities of Long Standing. *Journal of the American Medical Association,* LXXX, 18,

Fig. 7

Case 3. J. D. Anterior bowing of the femur. Before operation.

Fig. 8

Case 3. J. D. After operation, showing correction by application of the same operative principle.

1923), I reported the case of a man who had been helpless and unable to walk for thirty-eight years as a result of infantile paralysis. His locomotor power was eventually restored to him by a series of operations upon the soft parts. It gives me pleasure to report here a case of even more prolonged disability, restored to function by an operation upon bone.

CHRONIC SYNOVITIS OF THE KNEE WITH PERSISTENT OR RECURRING EFFUSION AND OF UNDETERMINED ETIOLOGY*

BY A. BRUCE GILL, M.D., AND THEODORE E. ORR, M.D.,
PHILADELPHIA, PENNSYLVANIA

Eleven cases of this interesting disease have been studied by the authors during the past fourteen years. One case was under observation and treatment for a period of ten years.

This condition is characterized by an effusion into the joint which persists for many months and even years in spite of all conservative methods of treatment, or which returns without apparent reason if, perchance, it had subsided. It is unaccompanied by any of the evidences of inflammation, such as pain, tenderness, local or general elevation of temperature, muscle spasm, or marked muscle atrophy. Motion is limited only by reason of the fullness within the joint cavity. There are no associated bone changes.

In all eleven cases the onset of this condition was between the ages of two and twelve years, the average being eight years. In eight cases there was an effusion into one knee only; in three cases, into both knees. Five were females; six were males.

No definite etiological factor could be found. There was no history of trauma or of preceding illness to which the condition could be ascribed. Removal of local foci of infection in teeth and tonsils, when found, did not alter the course of the disease. Cultures of the aspirated fluid and guinea-pig inoculations were consistently negative. The skin tuberculin reactions were negative in all. Wassermann tests of blood and spinal fluid were negative in all but two cases. In one of these two cases a positive reaction was obtained only after the administration of provocative doses of neoarsphenamine. Chemical and cytological examinations of the aspirated fluids did not afford any help in the solution of the etiology of this condition.

Treatment consisted of rest in bed, Buck's extension, plaster casts, splints, braces, baking and massage, heliotherapy, compression bandages and repeated aspirations. One case was operated on.

ASPIRATION OF KNEE

Aspiration of the knee joint was performed in those cases which presented evidence of having considerable fluid within the joint cavity. When the fluid reaccumulated, second and third aspirations were performed. As much as 320 cubic centimeters were obtained at one time. The fluid was nearly always thick and viscid. The color varied from

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lemon to dark amber. White blood cells varied in number, the highest being 360 cells in the high-powered field. Of these ninety per cent. were lymphocytes, and ten per cent. polymorphonuclear cells. In another specimen a differential examination showed:

Lymphocytes	65 per cent.
Polymorphonuclear cells	4 per cent.
Large mononuclear cells	21 per cent.
Red blood cells	10 per cent.

The last was probably due to the presence of blood caused by the aspiration.

CHEMISTRY OF FLUIDS

Creatinine	1.95 milligrams per 100 cubic centimeters
Chlorides	890 milligrams per 100 cubic centimeters
Sugar	109 milligrams per 100 cubic centimeters
Total protein	500 milligrams per 100 cubic centimeters

OPERATION

One case (W. S.) was operated on,—a partial synovectomy. When the knee was opened it was found to be filled with light straw-colored fluid which coagulated quickly on exposure to the air. The synovial membrane was reddened and thickened. There were enlarged, thickened fringes growing from the membrane covering the infrapatellar pad of fat. A pannus of granulation tissue grew over a portion of the articular cartilage of the internal condyle. When this was rubbed off with a piece of gauze the

TABLE I

Patient	Sex	Age	Age at Time of Onset	Knee Involved	Time Under Observation	Cured
W. S.	M	8 years	7 years	Right	2 years	No
H. H.	F	6 years	6 years	Left Right, 6 years later	10 years	No
L. G.	M	6 years	5 years	Right	3 years	Yes, for 2 years
A. H.	F	12 years	12 years	Left and right	8 months	No
W. W.	M	11 years	9 years	Left Right, 5 months later	5 months	No
W. M.	M	11 years	10 years	Left	6 months	No
D. M.	F	8 years	7 years	Right	5 months	No
R. K.	M	12 years	12 years	Right	1 year	No
S. S.	M	10 years	9 years	Right	6 months	No
A. K.	F	13 years	9 years	Left	19 months	No
A. B.	F	4 years	2½ years	Left	9 months	No

Note.—All patients were white.

cartilage lying underneath was found to be roughened and eroded. Enlarged and thickened portions of synovial membrane were removed.

The pathological microscopic examination of these tissues was as follows: "The tissue consisted of several pieces which seemed to be degenerated fibrous tissue and cartilage. One section showed fibrous cartilage partly normal and partly degenerated, in some places quite vascular, in one place so much so as to suggest angioma. There is a piece of fibrocellular tissue well supplied with capillaries that could be one of the articular fimbriae. This is very rich in cells but is not degenerated. A piece of muscle shows low-grade fibrous myositis; some of the blood vessels of the tissue show obliterating endarteritis. These changes are chronic inflammatory and degenerative and seem not to be those of any specific type of lesion."

Examination of this patient fifteen months after operation revealed that there was no fluid in the knee; there was considerable synovial thickening, no pain, no crepitation. Motion was present,—90 degrees to 180 degrees.

DISCUSSION

These cases of synovitis present a definite clinical history which seems to separate them from any other forms of synovitis with effusion with which we are familiar. The knee alone was affected; all other joints were normal. Nor have we ever seen a similar process in any other joint. It has been observed only in children.

It is not a traumatic synovitis. It does not resemble in any way Still's disease. It is not due, we believe, to focal infections, nor is it a manifestation of human tuberculosis. It is not a form of the recurring hydrops of the knee that is found in adults.

These joints are very similar to the Clutton's joints of syphilis hereditaria. Two of our cases had a positive reaction, as stated in a preceding paragraph. Since collecting these cases another has come to the attention of one of the authors in which there were similar manifestations in the knee, together with a strongly positive Wassermann reaction.

It is possible that these cases are all due to syphilis. We should not be satisfied with a negative blood Wassermann, but should examine the spinal fluid and should make a provocative test, if necessary. Also the parents of the child and other children in the family should be carefully examined for syphilis.

The authors present these cases in the hope that they may stimulate further study of their obscure etiology by the medical profession.

OBSERVATIONS ON FRACTURE HEALING IN RATS* †

BY MERRILL K. LINDSAY, M.D., F.A.C.S., NEW HAVEN, CONNECTICUT
Associate Clinical Professor of Orthopaedic Surgery

About two years ago a preliminary report was published describing the use of a beam test for determining the breaking strength of healing fractures. The method was developed in an effort to find some sufficiently accurate way of observing the rate of bone regeneration to establish a basis for comparison in the study of the factors involved in the process of bone healing. Briefly, the original conception was to produce a series of identical fractures to be observed under constant conditions for the purpose of producing a normal or basic curve of regeneration.

Realizing that a large number of observations would be necessary, the albino rat was selected as the experimental animal because of its availability and relative ease of maintenance.

Clinical experience in the management of fractures was used as a guide in outlining the problem, and on this basis the following selection of material and procedure was made. Males from four to eight months old were used. A six-months-old rat is comparable, from the standpcint of skeletal development and general metabolism, to a young adult man. The male was chosen as more stable from the metabolic standpoint. The variable factor of diet was met by using a constant diet throughout the experimental period and the animals used all ranged in weight between 190 and 300 grams. The exact procedure was given in a second paper entitled "Observations on a Standard Diet".

In the original study, only the fibula was fractured, but in later work the radius was used also. These bones were selected because the fibula and radius are perfectly splinted by the tibia and ulna. In the rat, the fibula is fused to the tibia at its distal end and the radius is so firmly attached to the ulna by an interosseous membrane that there is no rotation or change of relation possible between them. A complete fracture, therefore, of either of these bones required no protection or splinting and practically all the animals operated on used the fractured extremities in an apparently normal manner within twenty-four hours, thus eliminating the variable effect of disuse.

The fractures were produced under ether narcosis, after surgical preparation of the extremities, by a small longitudinal incision through the skin and fascia. The mid-shaft of the bone was exposed by separating the muscles along a fascial plane and the bone divided with scissors or osteoclast at the same level in each case. No sutures were used except silk in the skin. These sutures were removed by the animal itself when the

* From the Department of Surgery, Yale University School of Medicine.
† Presented at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 9, 1933.

healing was complete. No dressing was used and no infections were observed. At regular intervals following the operation, the animals were sacrificed and the fractured and unfractured fibulae removed and stripped of soft tissue. After measuring and weighing, the breaking strength was determined by placing each bone in a horizontal position on two supports at its extremities and gradually applying a load in the center until the bone broke. The load was applied by running water at a uniform rate of speed into a receptacle attached to the end of a lever arm resting on the bone. At the instant of fracture, the flow of water was stopped and the amount in the receptacle weighed in grams. The description of the machine for breaking and the method used were described in a preliminary report.

During the first 2000 observations, only the right fibula was broken and the left used as a control. The breaking strength was determined after thoroughly drying the bones and the observations were made at three-day intervals for the first forty-five days. The result of the part of the work done to establish a normal or base line for the healing rate indicated no appreciable strength in the previously fractured bone before the sixth day. From this time until approximately the fifteenth day, the strength increased and the callus reached its maximum size by measurement. From the fifteenth to the twenty-first day, the breaking strength fell and the callus diminished in size. Histological studies of the fracture site during this period revealed relatively large areas of absorption with a general structural reorganization taking place. From about the twenty-first to the forty-fifth day, the breaking strength increased, and the size of the callus decreased, and at the end of this period some of the bones began to break at points other than the fracture site, showing that the regenerated portion was as strong at least as other parts of the shaft. It also appeared from the results that the size and weight of the bone could be directly correlated with the breaking strength and that the variations in the breaking strength bore a definite relation to the three natural stages of regeneration: fibrosis, calcification, and structural reorganization.

The next phase of the problem was concerned with dietary substitutions. Using the normal or basic curve just described for comparison, observations were made on the following dietary changes:

High fat.
High carbohydrate.
High protein.
Low total salts.
Low calcium.
Low phosphorus.

The basic problem was repeated with each of these diets, using the same number of animals and equal observation periods. The diets themselves were variations in the original standard diet by increases or reductions of the components mentioned. The purpose of these studies was to obtain

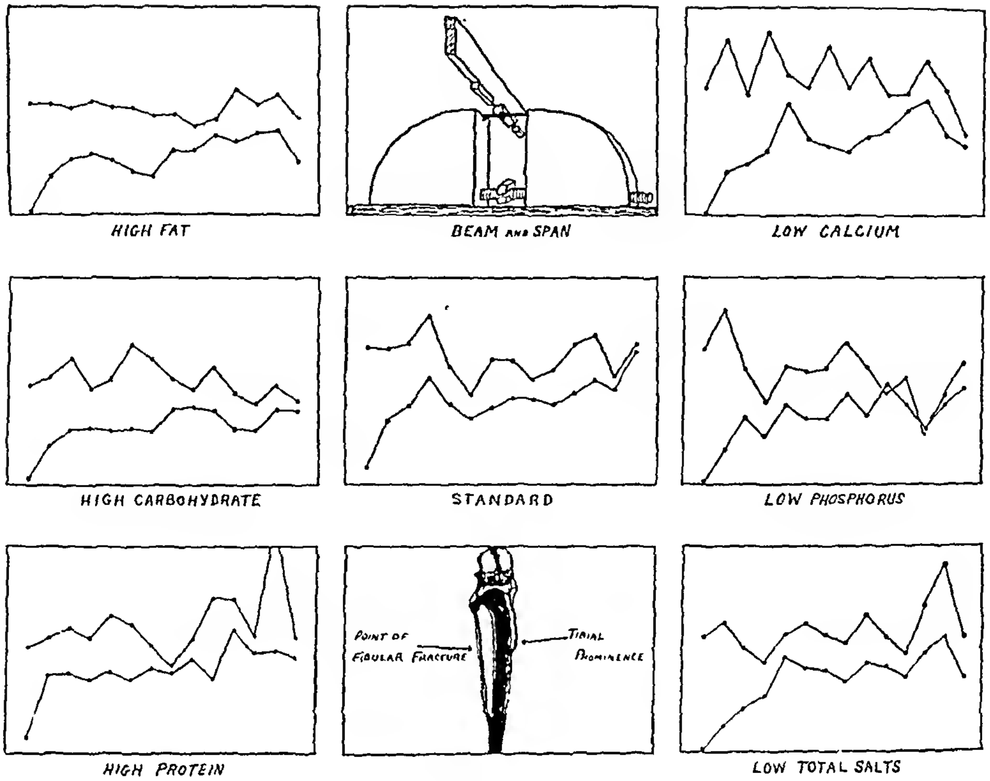

FIG. 1

The upper or control curve in each block indicates either no gain in strength or a loss in strength on the last observation period, indicating dietary imbalance. The experimental animals were young and the controls should have shown an increase in strength as the animal gained in weight and size.

leads which might be followed with a more intensive study should any marked change in the basic healing rate be indicated by any of these dietary changes.

In studying the results of this work, it was observed that the animals had not shown a normal weight and growth curve during the experiment and that the strength curves of both fractures and control animals were either flat or showed a downward tendency. This was taken as an indication of dietary imbalance. The animals used were received from the dealer about one week before being operated upon, and the time was obviously too short to establish a dietary equilibrium, even though the new diet was adequate. It was felt, therefore, that while the results might have significance in the light of further studies, it would be necessary to adjust the conditions sufficiently to insure a dietary equilibrium before demonstrating a basic curve and certainly before attempting to interpret results of dietary substitution. The results of this work are shown by the plotted curves based on ratios of the breaking-strength figures (Fig. 1).

About one year ago a fresh start was made and the entire basic problem was repeated with the following changes: Only animals raised in the institution from first quality stock and known to be within one week of six months old were used. All the animals were placed on a calf-meal diet at the age of weaning, which was six weeks, and maintained on this

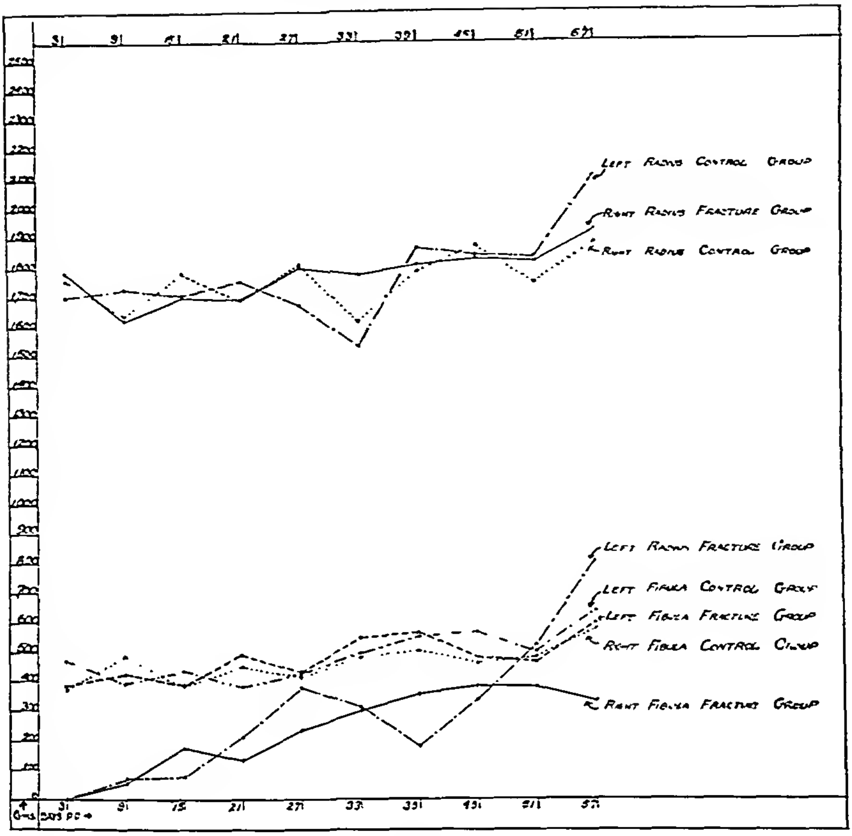

Fig. 2

The two lower curves show the rate of regeneration of fractures of the fibula and radius. The radius shows the same characteristics as the fibula but requires a longer period for regeneration.

The two upper groups of curves represent the controls in both fractured and unfractured groups. These indicate only that the strength at the end of the experimental period is somewhat greater than at the beginning, which is explained by the increase in size and weight of the animal.

diet throughout the experiment. These changes practically eliminated the variable factors of age and dietary equilibrium.

It having been previously noted that a direct ratio existed between the weight of the animal, the length of the bone, and the breaking strength, only animals weighing between 250 and 300 grams were used. Drying of the bones before breaking was discarded as an unnecessary complication and possible source of error, because it increased the resistance of an unknown quantity of fibrous tissue. In addition to the above, it was decided to break the left radius as well as the right fibula so as to have fractured bones of different weights and lengths for comparison.

The animals for this work were divided into two groups of six each for each observation period. In one group, the left fibula and right radius were fractured and in the other, or control group, an equivalent procedure was carried out, consisting of narcosis, preparation, and operation to the

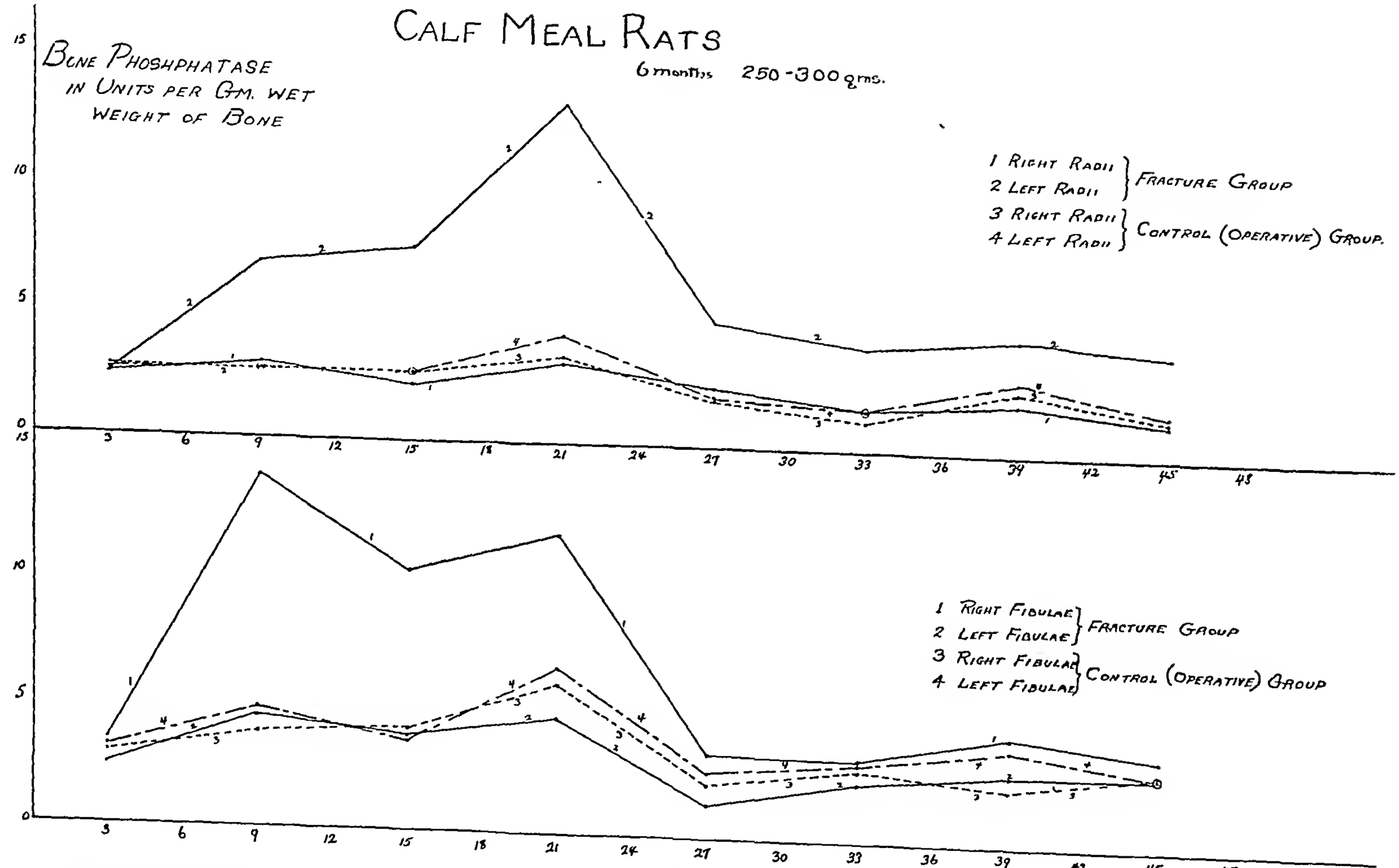

FIG. 3

The upper curve shows the phosphatase concentration in fractures of the radius and the lower curve the phosphatase concentration in fractures of the fibula, the maximum concentration occurring about the twenty-first day in the radii and about the ninth day in the fibulae, which indicates a correlation with the curves of regeneration as shown in Fig. 2.

point of exposing the bone, but without any bones being fractured. This gave two sets of controls,—the opposite unfractured bones of the fracture group and the opposite bones of the operated but unfractured group. The observation intervals were six days instead of three, because previous work indicated that no substantial increase of evidence would be obtained by the shorter intervals. This work indicated, however, that the total observation period would have to be lengthened and data now collected cover a total of fifty-seven post-fracture days and the end point has not been reached. More than 2000 further observations have been made with the new conditions and it is interesting to find that the basic curve for the fractured fibula remains essentially the same as the original, and shows variations in strength corresponding to the three stages of bone healing previously mentioned. It is also noted that the curve for the fractured radius has the same characteristics over a longer period. Since the results on the fibula confirmed the original findings and the results on the radius were similar in character and consistent in occurrence, there seems to be definite indication that the method gives a true index of the rate of bone regeneration. The longer period required for healing the radius is an indication that the relative rate of regeneration is not the same for all bones. The results of this work may be seen in the plotted curves based on actual figures in Figure 2.*

In addition to breaking-strength observations, phosphatase determinations were done on the fractured and unfractured bones of each group of animals. Although the importance of phosphatase in bone production may be regarded as hypothetical, the results of this work are perhaps significant. The high point of phosphatase concentration is found to occur a few days prior to the primary peak of calcification in both fibula and radius. This observation corresponds in time relation with the work of Fell and Robison who observed the first appearance of phosphatase in vitro cultivation of embryonic femur a short but definite time before the actual deposition of lime salts. Plotted curves of phosphatase units per gram weight of green bone are shown in Figure 3.

The work outlined in this report is being carried forward diligently at the present time and it is hoped when end points on healing are reached and further observations on the chemistry of the process are available for comparison, it will be possible to interpret the results for clinical application.

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* The author is indebted to Alexander L. Bassin, Davis and Geck Fellow in Surgery, for experimental data on the rate of healing between radii and fibulae in rats, and to Edward B. Hopper, Harvey Cushing Fellow in Surgery, for data on phosphatase determination in bone regeneration. These studies will be published in detail later.

INTRACAPSULAR FRACTURES OF THE HIP

A New Device for Lateral Osteosynthesis

BY MYRON O. HENRY, M.D., MINNEAPOLIS, MINNESOTA

From the Department of Anatomy, University of Minnesota

Because the available methods of closed reduction of intracapsular fractures of the hip fail in many cases, there is a steadily increasing inclination toward open surgical attack in selected cases. At the present time it seems unlikely that open operative methods will ever come into general use; nevertheless the improved results reported to date (Smith-Petersen[1], Hey Groves[2], Bozsan[3], and Ellis Jones[4]) indicate that capable surgeons will probably undertake suitable operative procedures more often in the future.

In order to warrant the additional risk of open surgical attack on fresh intracapsular fractures of the hip, a satisfactory operative procedure should permit the removal of interposing soft parts and should secure accurate and close contact of the fractured surfaces. A satisfactory operative procedure should also provide effective immobilization that is comfortable throughout the healing period.

A rustless steel screw-bolt has been devised by the author for this purpose, and the following operative procedure has been developed in the laboratory. It is suggested to surgeons accustomed to operating upon the hip, because it meets many of the objections to open surgical attack.

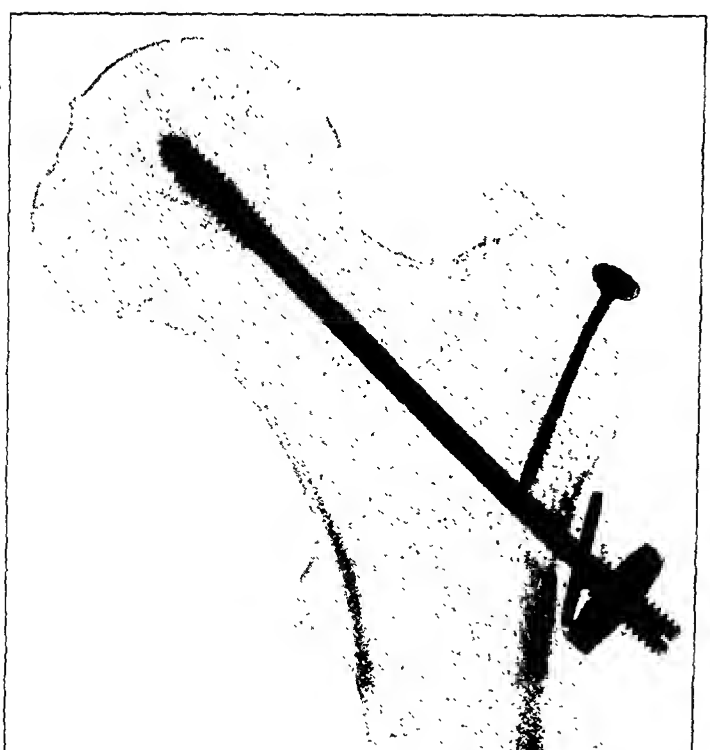

Fig. 1
X-ray of screw-bolt in place.

Moderate traction is applied to both lower extremities of the patient upon an orthopaedic operating table. Through a long lateral incision the trochanter is exposed thoroughly. Next a Gigli saw is passed through the trochanteric fossa beneath the tendons of the obturators and piriformis muscles. The trochanter is

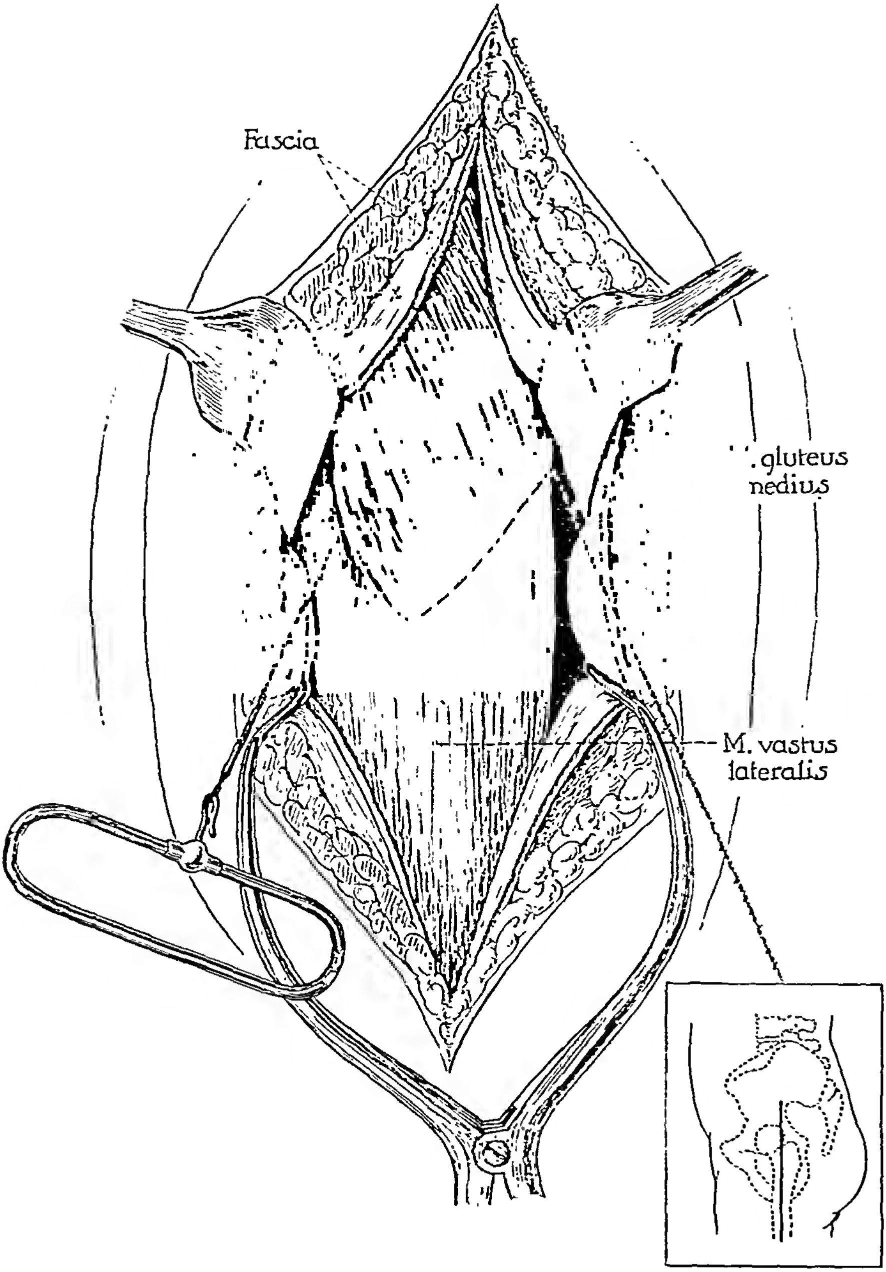

FIG. 2
Transtrochanteric approach.

sawed off obliquely along the insertion of the gluteus medius tendon and is retracted upward with these muscular insertions intact (Fig. 2). When the capsule of the hip is incised, this approach gives an excellent view of the femoral head and neck *along the axis of the neck.* Interposed soft parts

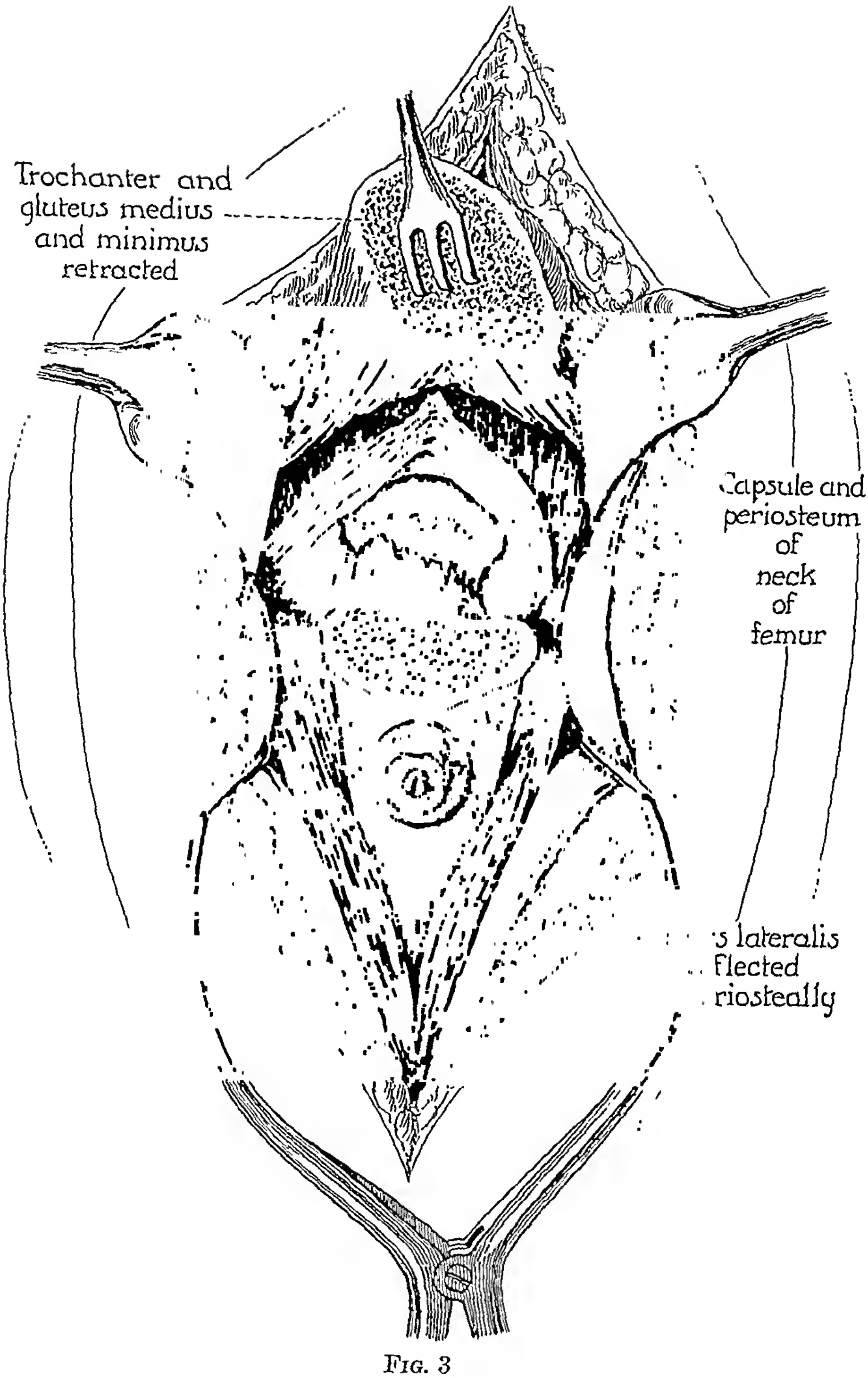

FIG. 3
Lateral osteosynthesis.

can be removed, and the fragments brought into apposition by the screw traction of the table. The head of the femur is steadied by a tenaculum forceps, while a hole is drilled accurately into it along the axis of the neck. The screw-bolt is then introduced and drawn up tightly to secure efficient fixation (Fig. 3). The capsule is sutured, the trochanter sutured (or nailed) into place, and the fascia and skin are closed in the usual manner.

No external immobilization is needed, and the device can be removed through a small lateral incision when desired. This procedure is suggested

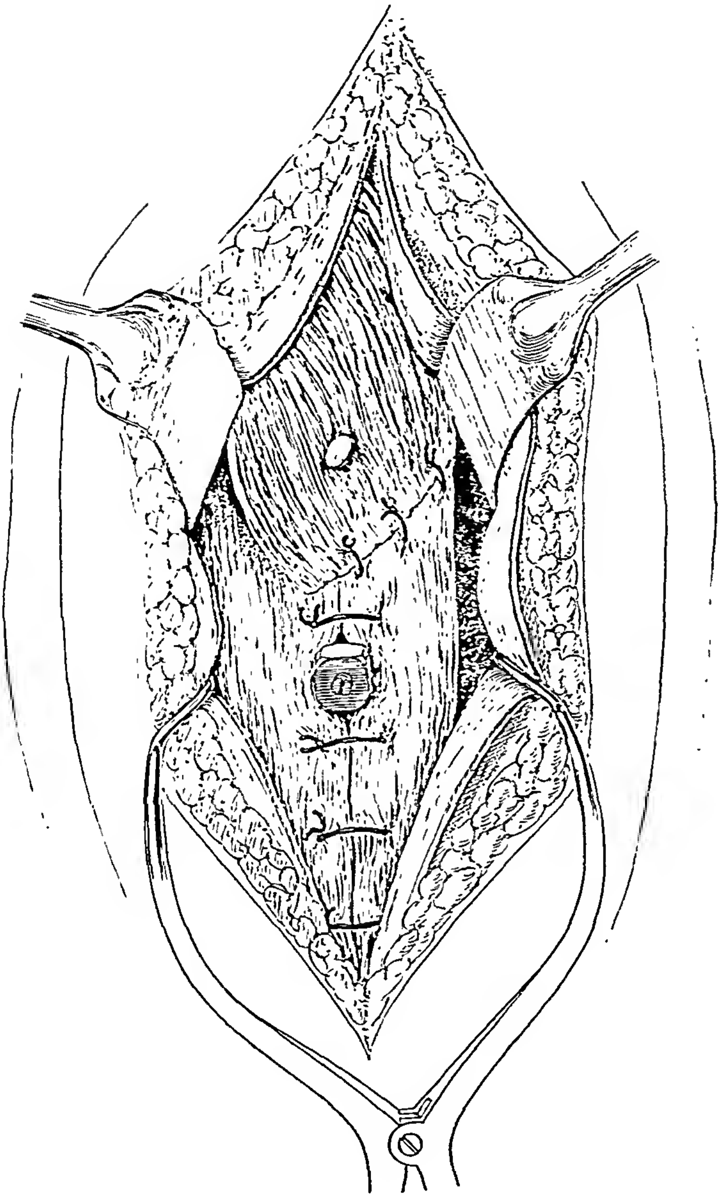

FIG. 4
Closure of wound.

because it provides firm internal fixation [5] with little trauma to the head and without disturbing the remaining soft-part attachments of the head [6]. It permits removal of interposed soft parts and secures close and accurate apposition of the fractured surfaces. Active motion can be secured early by this procedure, and the patient can be comfortable throughout the healing period.

Because this operation is advocated for special cases, it has been tested clinically in only three cases. The first case, done nearly two years

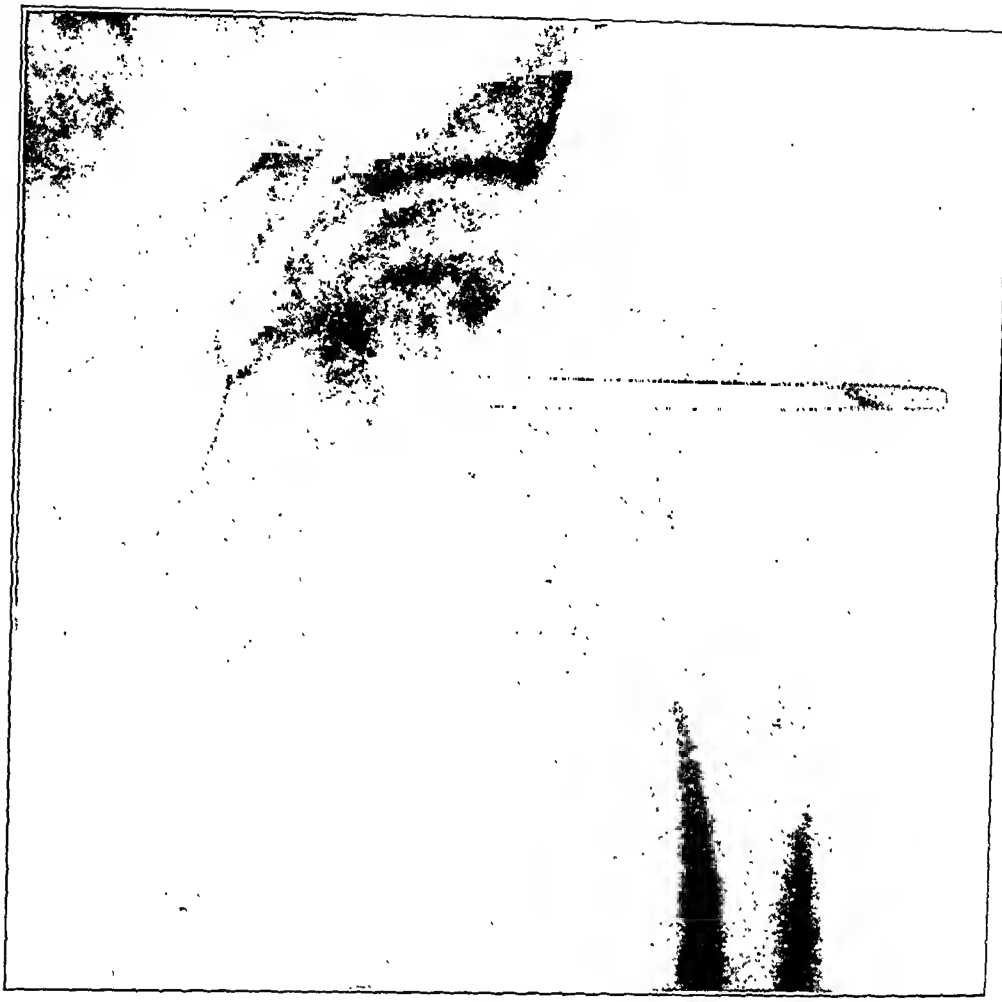

Fig. 5

Roentgenogram taken thirteen months after operation and insertion of screw by Dr. E. T. Evans, Minneapolis. Excellent clinical result. Patient refused to have screw removed.

ago by Dr. E. T. Evans of Minneapolis, was ambulatory without crutches five months after operation. The patient is so well pleased with the end result that he has not bothered to have the screw removed. Capable surgeons, who are accustomed to operating upon the hip, will find the operation of great value in selected cases.

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THE TREATMENT OF SURGICAL TUBERCULOSIS WITH SPLENIC EXTRACT

BY JOSEPH S. BARR, M.D., BOSTON, MASSACHUSETTS

From the New England Peabody Home for Crippled Children

Medical literature has carried articles for several years past reporting the use of spleen or splenic extract in improving cases of pulmonary tuberculosis. Bayle[1,2] and Fliegel[3] in particular have emphasized its value. Wheeldon[4] seems to have been the first, in this country at least, to have used it in cases of joint tuberculosis. He found that his cases improved rapidly while using it, and he finally prescribed it for every case, abandoning any attempt to evaluate his results by the use of control cases. At his suggestion, we have added splenic extract (calves' milt) to the diet of a group of cases of surgical tuberculosis at the New England Peabody Home for Crippled Children, and herewith report the results of our investigation.

Selection of Cases:

Twenty children, each with acute tuberculosis of the hip or spine, being treated conservatively in recumbency with heliotherapy, etc., were selected. Ten of these cases were used as experimental subjects and the other ten as controls. Each case was paired with its control as carefully as possible for age, duration and extent of the disease, prognosis, etc. There were no cases with amyloid disease or secondarily infected sinuses in either group.

Treatment:

The cases of Pott's disease were all treated in hyperextended plaster shells. The tuberculous hips were on Bradford frames with adhesive traction extension. Each case had the usual intensive heliotherapy, high vitamin, high caloric diet, complete rest in recumbency, nursing care, etc., which we[5] feel constitutes adequate conservative treatment. The one variation was the use of splenic extract in the diet of ten of the cases for a period of one year, December 1931 to December 1932. Both the powder and liquid extracts were used. The usual dose was one teaspoonful three times a day. Almost every child receiving the extract had occasional nausea and vomiting, but there were no cases in which the medication had to be discontinued. It was felt that, if splenic extract exerted any marked beneficial results in cases of surgical tuberculosis, it should be evident after a few months, but to make certain we continued the medication for one year. An additional nine months has now elapsed and a final clinical check-up has been made.

Method of Study:

In order to determine the general and local clinical condition of each patient, a definite routine was adopted which was briefly as follows:

Each case had a complete examination every six weeks which included detailed measurements of joint motion where possible, notes as to muscle spasm, size of abscess, etc. The nutritional state was noted and also the child's general condition, susceptibility to colds and infections, etc. Weights were recorded every two weeks. Laboratory work included count of red blood cells, white blood cells, hemoglobin, and differential count every week; complete urine examination every week; roentgenographic examination every two months; intradermal tuberculin tests, using graded doses at the beginning and end of the study.

It was felt that these data would give a fair estimate of the general condition of the child, and the status of the local lesion.

Weight: The group fed spleen averaged a little less weight gain than the control group. We attributed this to fairly frequent gastric upsets, nausea and vomiting and refusal of food, due chiefly to the unpleasant taste and smell of the extract.

Blood: There was no essential or striking difference in the total and differential white-blood count of the two groups. None of the children had anaemia of any consequence, and so neither group of children showed changes in the hemoglobin or red-blood-cell counts greater than the usual seasonal and individual variations. A group of cases with severe anaemia, due to secondary infection or other causes, might have shown better results if fed spleen, but there was no such group available to us.

X-Ray: The progress of a tuberculous hip or spine in process of healing is perhaps most easily recorded by serial roentgenograms taken at regular intervals. Each child fed calves' milt and its control case were x-rayed every six weeks. When the study was completed at the end of one year, these films were carefully compared for evidences of variation in amount and rapidity of destruction, decalcification, and regeneration, size of abscess, calcification, etc. By x-ray only one of the cases seemed definitely better than its control; seven showed essentially the same picture; two seemed to be poorer results.

Clinical Results:

The examination of the patients and comparison of joint motion, muscle spasm, and all the other local and general manifestations of improvement are actually the best criteria of progress in recovery from joint tuberculosis. Detailed notes were made at intervals of six weeks on the local and general condition of each patient and compared with his previous examination and also with the control case. As an additional check, the cases were also presented in pairs and examined by a group of orthopaedic surgeons one year after beginning treatment. By comparison of the patients' condition and their roentgenograms, the physicians were asked to decide which of each pair of cases was the better. These physicians, of course, did not know which patients had received splenic extract and which were controls. Of the ten pairs, seven were considered to have made almost identical progress and were in approximately the

same local and general physical condition. In one case the child fed splenic extract was found to be much better generally and locally than the control, while in two cases the reverse was true,—*i. e.*, the control case seemed to have done better than the one fed splenic extract.

COMMENT

Experimental clinical work is notoriously difficult and the results of such experiments are hard to interpret. Twenty cases (ten pairs) are all too few on which to base any statistical study and, for that reason, no attempt is made in this paper to give tabular details. The fact remains that, as nearly as could be determined by us, splenic extract (calves' milt) added to the diet of children having uncomplicated joint tuberculosis seemed to have no effect on the course of the disease.

The evidence as given is not wholly conclusive but we feel justified in discontinuing the use of splenic extract in such cases until further proof of its usefulness is adduced.

We wish to thank the Valentine's Meat-Juice Company for their generous assistance in furnishing the splenic extract S.V.2 for these experiments.

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THE EFFECT OF A LOCAL CALCIUM DEPOT ON OSTEOGENESIS AND HEALING OF FRACTURES *

BY J. ALBERT KEY, M.D., ST. LOUIS, MISSOURI

From the Department of Surgery of the Washington University School of Medicine, and Barnes Hospital, St. Louis, Missouri

In spite of the very considerable amount of investigation which has been directed toward the problem of ossification we remain ignorant on two of the salient points,—*viz.*, the mechanism by which calcium is deposited in the organic bone matrix and the immediate stimulus which leads to the formation of bone in a given location. In the main the theories of ossification may be grouped as humoral or chemical and cellular or vital. In other words, bone is formed as a result of some local chemical phenomena or it is the product of specific cells (osteoblasts) which have the capacity of laying down bone when conditions are right for them to do so. When bone is formed in abnormal locations, the cellular theory provides the specific cells by assuming that under appropriate conditions the omnipresent, primitive, connective-tissue cell can differentiate into an osteoblast.

Leriche and Policard [1] champion the humoral theory and postulate "a local calcific surcharge as the determinant of osteogenesis in a suitable fibrous medium". They emphasize the rarefaction of bone at the extremities of the fragments, which occurs after a fracture, and believe that this liberates calcium in the vicinity and leads to a local excess of calcium and that this is an important factor in the union of fractures. Murray [2] thinking along similar lines, was able to produce bone in traumatized muscle by placing calcium phosphate and carbonate in the injured tissues, and used calcium phosphate and carbonate in the proportions in which they occur in bone as a stimulant for osteogenesis in the healing of bone defects and in the treatment of fractures which had failed to unite.

While I am an adherent of the cellular theory of osteogenesis, I have recognized the fact that the cells must have calcium with which to form bone, and have felt that they might work more efficiently if this material were supplied in abundance. In other words, if a defect in bone could be filled by a non-irritating, slowly soluble mass, which was porous and which contained calcium phosphate and carbonate in a form in which they could be resorbed, it would be reasonable to expect osteoblasts to invade the mass, utilize the calcium, and build new bone which would replace the mass of calcium and cause the bone to be restored to its original form.

The ideal material would appear to be rather dense cancellous bone from which a large percentage of the organic material had been removed. Consequently, in 1926, I treated cancellous bone with sodium hydroxide

* Read before the Section on Orthopaedic Surgery, American Medical Association, Milwaukee, Wisconsin, June 16, 1933.

until most of the organic matter was removed and then used this deorganized bone as grafts.

In 1927, Dr. William Hamm and I performed a series of experiments in which holes, one-fourth of an inch in diameter, were drilled in the femora of large dogs and these holes were then closed with trephine plugs of cancellous bone or with bone powder. Eight holes were drilled in each femur and these were filled with the following:

1. Bone fixed in formalin and washed.
2. Bone fixed in alcohol and washed.
3. Boiled bone.
4. Cancellous bone treated with alkali for a short period.
5. Cancellous bone treated with alkali until it was chalky and easily crushed.
6. Bone powder made by treating bone with alkali until it disintegrated and then washing it in running water for several days.
7. A paste made of the bone powder mixed with the blood of the animal.
8. Control left open.

We performed sixteen such experiments and sacrificed the animals at intervals of from one to sixteen weeks. Roentgenographic and gross and microscopic study of the specimens did not permit us to draw any conclusions as to the relative value of the materials, because the control defects healed as rapidly as did those which were filled with fixed and boiled bone, deorganized bone, or bone powder.

Since then I have performed experiments in which I have attempted to bridge defects in the shafts of the ulnae of dogs with pastes made of bone powder mixed with cement, acacia, or fresh blood. In spite of the fact that my experimental results were not encouraging, I was impressed by Murray's clinical observations and have used the calcium phosphate and carbonate in clinical cases where I wished to stimulate osteogenesis, as in filling cavities created by extensive saucerization operations performed in attempts to cure chronic osteomyelitis, in arthrodesing operations, and in operations for non-union of fractures. Following a suggestion of Dr. Wallace Cole, I have, in several cases of brittle bones, stripped up the periosteum of both femora and both tibiae and placed calcium salts beneath the periosteum in an attempt to increase the diameter of the shafts of these bones and thus make them suitable for weight-bearing. A review of our clinical cases at the Shriners' Hospital for Crippled Children and at the Barnes and Children's Hospitals, left me unable to draw any conclusions as to whether or not the calcium salts in the wound were of any real value. In some instances they seemed to stimulate osteogenesis, but in others they appeared to have no effect.

Consequently, the experiments which are reported in this paper were performed in an attempt to determine whether or not a local depot of calcium salts is of any value in stimulating osteogenesis.

The material consisted of twenty adult dogs, each of which was

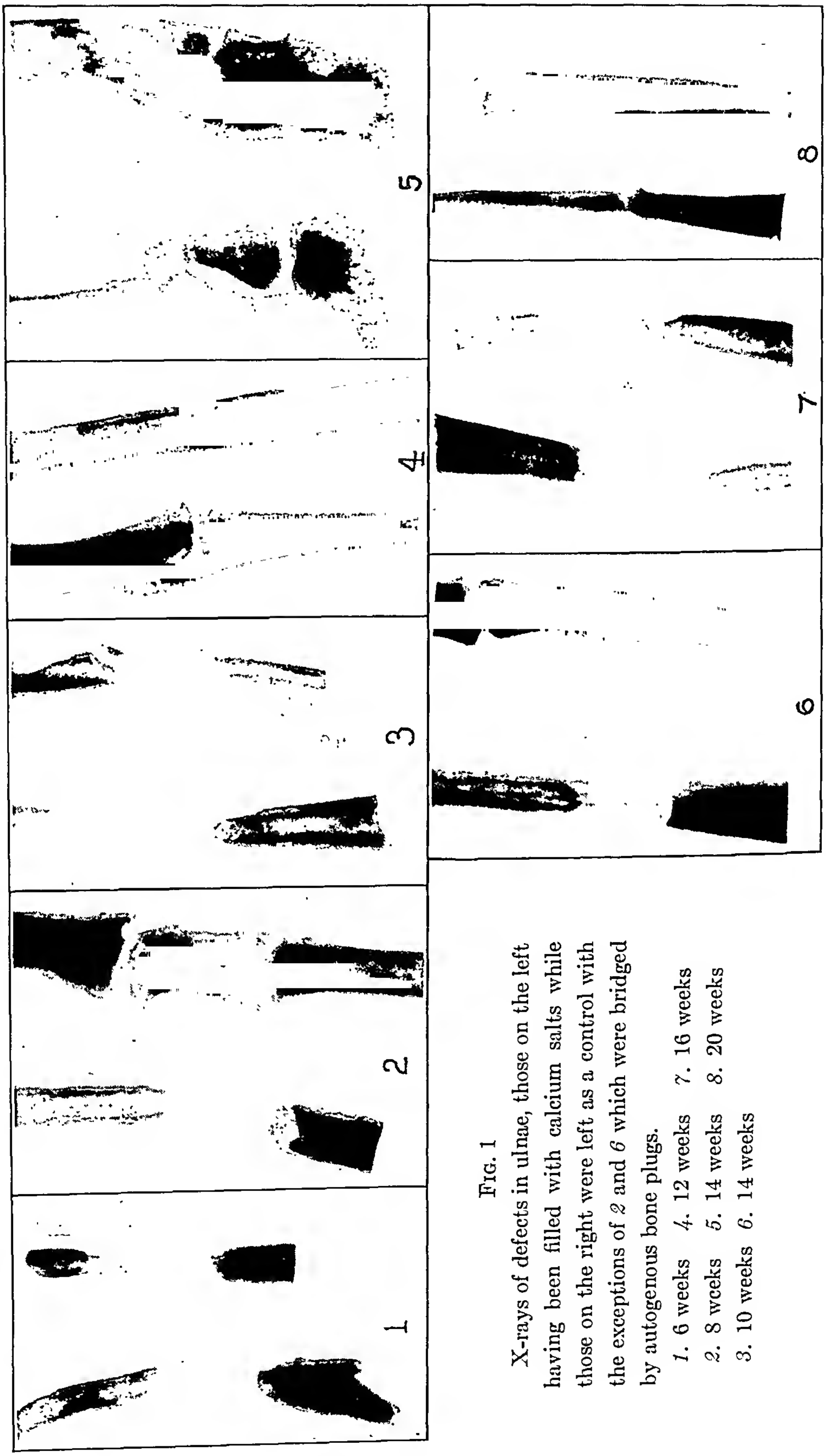

Fig. 1

X-rays of defects in ulnae, those on the left having been filled with calcium salts while those on the right were left as a control with the exceptions of *2* and *6* which were bridged by autogenous bone plugs.

1. 6 weeks	*4.* 12 weeks	*7.* 16 weeks
2. 8 weeks	*5.* 14 weeks	*8.* 20 weeks
3. 10 weeks	*6.* 14 weeks	

operated upon under general anaesthesia and at the operation from 1.5 to 2.5 cubic centimeters of the shaft of each ulna were resected. It was desired that the defects be just large enough to prevent union. Consequently, in the younger dogs and in the dogs with large bones the defects were longer, because experience has shown that longer defects will heal in young animals and that the diameter of the bone roughly determines the length of a section which can be removed from the shaft of this bone and not result in non-union. In adult dogs this is about one and one-half times the diameter of the shaft of the bone. Defects in the two ulnae of the same animal were made as nearly uniform as possible. An attempt

TABLE I

Time (*Weeks*)	Right		Left	
	Defect Bridge	Union	Defect Bridge	Union
6	Calcium	0	Control	0
8	Calcium	0	Bone plug	+ +
10	Calcium	0	Control	0
12	Calcium	+ + +	Control	+ + + +
14	Calcium	+ +	Control	+ +
14	Calcium	0	Bone plug	+ + +
16	Calcium	0	Control	0
20	Calcium	+ +	Control	+ + + +

Results of experiments in which defect in the right ulna was filled with calcium salts and that in the left ulna was left as a control or bridged by an autogenous bone plug. Zero is non-union and 4-plus is solid bone union.

was made to preserve a periosteal bridge between the fragments and in the young dogs this amounted almost to a sleeve of periosteum and in the old dogs it amounted to a bridge on the deep surface and periosteal shreds around the rest of the bone. In eight of these dogs the defect in the right ulna was filled with calcium and in six others the defect in the right ulna was filled with bone powder. In six of the dogs the defect in the left ulna was left as a control, while in the remaining dogs the defects were filled with bone plugs, used either as boiled or living autogenous grafts or with living bone hash, made by cutting up the piece removed from the opposite leg. Where bone plugs were used, the plug from one ulna was placed in the defect in the opposite ulna. With the exception of one leg, in which the bone plug became displaced and became infected, the wounds

healed without complications and the dogs experienced little difficulty after the operation as the intact radius was sufficient to support the body weight and enable the forelegs to function normally. The animals were sacrificed at intervals of from four to twenty weeks. The ulnae were removed, inspected in the gross, and were then x-rayed, and, after fixation and decalcification, were sectioned and stained, and studied microscopically.

The results of the experiments are shown in the tables and illustrations. On gross and roentgenographic examination, partial union occurred in four instances in which calcium or bone powder was used in

TABLE II

	Right		Left	
Time (*Weeks*)	Defect Bridge	Union	Defect Bridge	Union
5	Bone powder	0	Bone plug	+
6	Bone powder	0	Bone plug	+
7	Bone powder	0	Bone plug	+
10	Bone powder	+ +	Bone plug	+ + + +
12	Bone powder	0	Bone plug	+ +
16	Bone powder	0	Bone plug	+ + + +

Results of experiments in which defect in the right ulna was filled with bone powder and that in the left ulna was bridged by an autogenous bone graft. Zero is non-union and 4-plus is solid union.

the defect. But in the same animals union also occurred in the opposite leg which was used as a control and in which the defect was not bridged by anything except periosteum. In the other ten animals, in which the defect was filled by calcium salts or by bone powder, union did not occur.

In the roentgenograms the calcium salts were visible, in the early experiments, as a faint shadow between the ends of the fragments. In the later experiments, this shadow had entirely disappeared and there was no demonstrable difference between the defects which had been bridged by calcium and the controls. In the instances where bone powder was used to bridge the defects, this was visible as a dense shadow between the fragments, and, as it usually contained several small fragments of bone, these also could be seen in the roentgenogram. However, in the later experiments with bone powder, the smaller bits tended to disappear, while the larger fragments tended to remain as isolated masses. In neither the calcium nor the bone-powder experiments, was there any tendency for the fragments to unite more readily than they did in the controls, nor

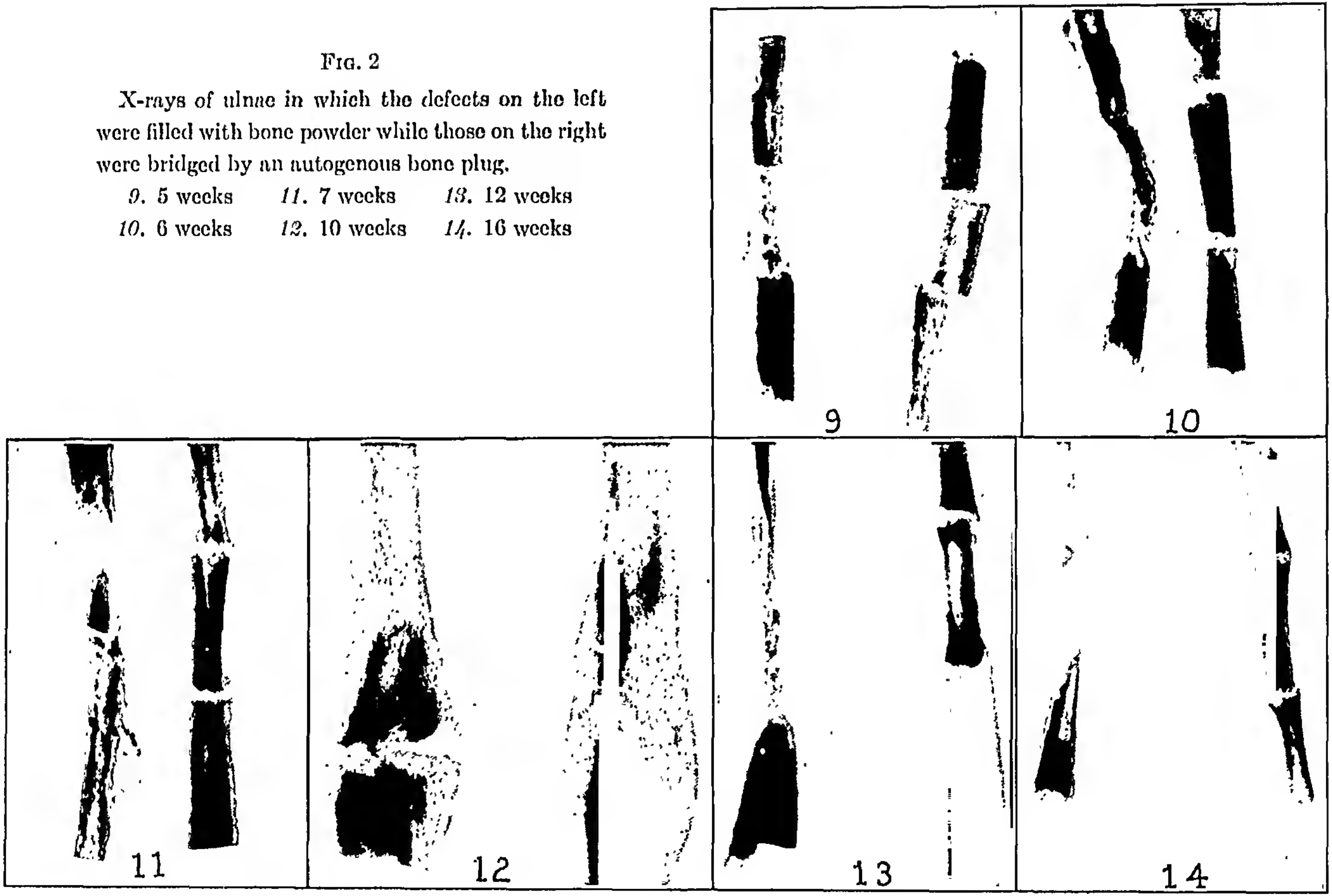

Fig. 2

X-rays of ulnae in which the defects on the left were filled with bone powder while those on the right were bridged by an autogenous bone plug.

9. 5 weeks *11.* 7 weeks *13.* 12 weeks
10. 6 weeks *12.* 10 weeks *14.* 16 weeks

was the local atrophy which tends to occur in cases of non-union prevented. In fact, the ends of the fragments tended to assume the same pencil-like appearance as did those in the controls. Where living bone plugs and living bone hash were used, union tended to occur and the bone plugs tended to unite to the ends of the fragments, while the bone chips fused into a solid mass of callus in which the more dense fragments could be identified over a period of several weeks, and then lost their identity, and the structure tended to become homogeneous and resemble the normal bone structure. Where boiled bone plugs were used, union was delayed, as there was not the same tendency for union to occur between the end of the fragments and the graft as there was when a plug of living bone was inserted in the defect.

TABLE III

Time (*Weeks*)	Right		Left	
	Defect Bridge	Union	Defect Bridge	Union
4......	Boiled bone plug	+	Bone chips	+ +
8......	Bone plug	+	Bone chips	+ + + +
10......	Boiled bone plug	+	Bone chips	+ + + +
12......	Boiled bone plug	+	Bone chips	+ + + +
14......	Bone plug	+ + + +	Bone chips	+ + + +
16......	Boiled bone plug	+ + +	Bone chips	+ + + +

Results of experiments in which defect in the right ulna was bridged by an autogenous or a boiled bone plug and in which the defect in the left ulna was bridged by autogenous bone chips. Zero is non-union and 4-plus is solid union.

Microscopically, signs of the calcium salts could be identified in the sections as small, clear areas which were surrounded by living cells. Apparently these salts were removed by solution rather than by phagocytosis. However, in some instances the small areas were surrounded by macrophages and there was an occasional foreign-body giant cell. But no traces of the calcium salts were seen in the giant cells. In other instances the mass of calcium and fibrin was invaded by connective-tissue cells and the end result was a mass of loose connective tissue, the clear spaces of which appeared to have been filled with calcium. Relatively little calcium remained in the specimens which were removed ten and twelve weeks after the operation. The bone powder, on the other hand, always contained small fragments of dead bone. As the mass of bone powder was invaded by connective-tissue cells, these minute particles were surrounded by a fibroblastic wall and might persist in the tissue over

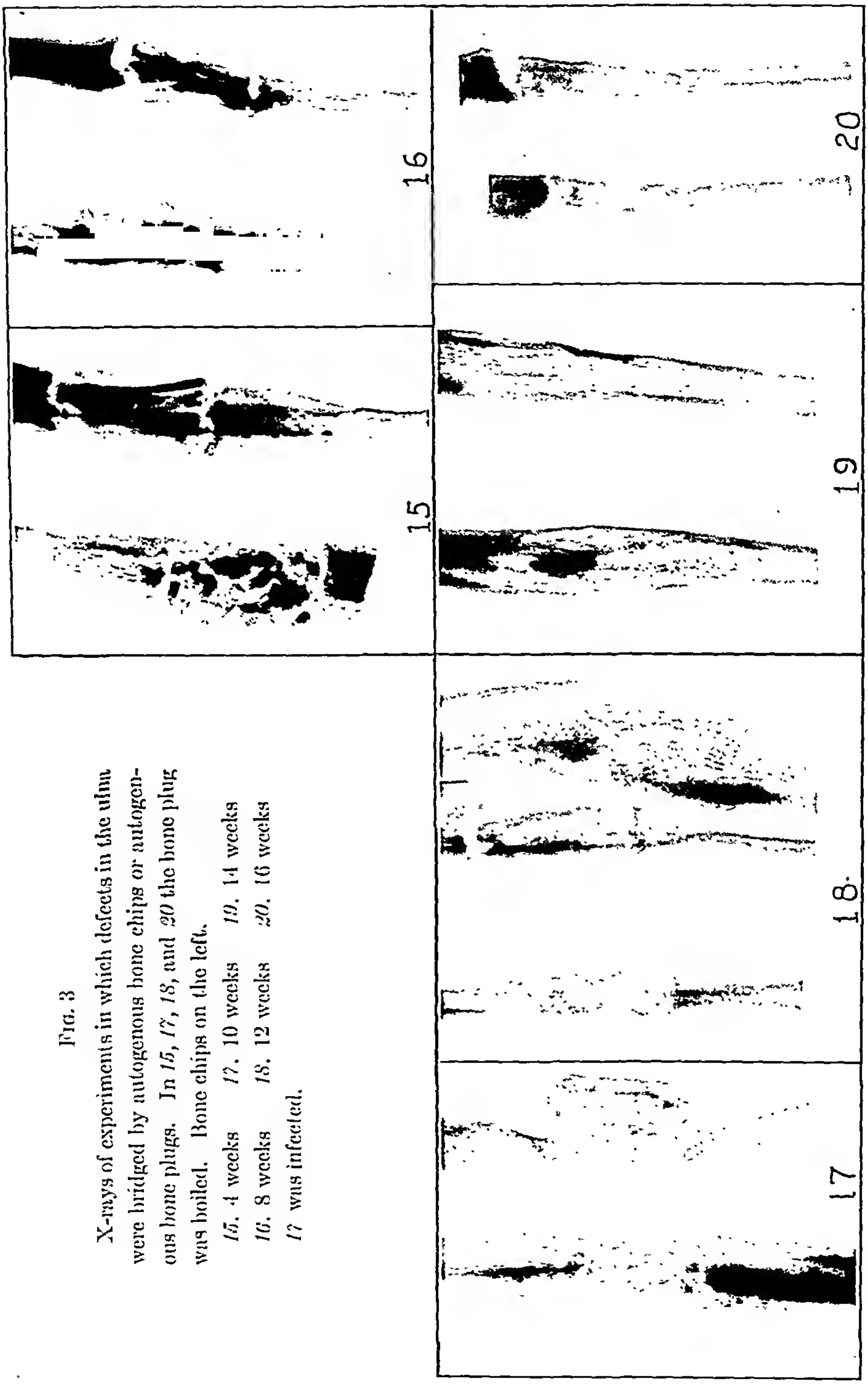

Fig. 3

X-rays of experiments in which defects in the ulna were bridged by autogenous bone chips or autogenous bone plugs. In *15*, *17*, *18*, and *20* the bone plug was boiled. Bone chips on the left.

15. 4 weeks *17*. 10 weeks *19*. 14 weeks
16. 8 weeks *18*. 12 weeks *20*. 16 weeks
17 was infected.

a long time. Here, too, there was a slight tendency for the fragments to disappear, apparently by solution rather than by erosion by living cells.

CONCLUSION

Neither calcium phosphate and carbonate in the proportions in which they occur in bone, nor bone powder, made by removing the organic matter from bone, appear to stimulate osteogenesis of bone when implanted in a bone defect.

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THE CYSTINE CONTENT OF THE FINGER NAILS IN ARTHRITIS

BY M. X. SULLIVAN, PH.D., AND W. C. HESS, PH.D., WASHINGTON, D. C.

Chemo-Medical Research Institute, Georgetown University, Washington, D. C.

In applying the Sullivan[1,2] cystine method to widely different material, *i.e.*, foodstuffs, hormones, enzymes, etc., Sullivan and Hess[3] found that the cystine content of the finger-nail clippings of six normal individuals varied from 11 to 13 per cent. with an average of 12 per cent., while one arthritic, diagnosed by his physician as a case of infectious arthritis, showed only 8.87 per cent. The finger-nail clippings of this case of arthritis were analyzed once a month for six months. At the end of the study the young man was in good condition and the cystine content of his finger nails had risen to 11.3 per cent., within normal levels.

This one case of arthritis suggested the desirability of studying the cystine content of a relatively large number of cases of arthritis.

Accordingly, the finger-nail clippings of twenty-six normals and of 103 arthritics were analyzed for cystine. The procedure of analysis is as follows: Fifty to 100 milligrams of finger-nail clippings were placed in a small acetylation flask, fitted with a ground-glass reflux condenser, together with five cubic centimeters of twenty per cent. hydrochloric acid. The mixture was heated in a crisco bath at 125 degrees, centigrade, for seven to eight hours. The contents of the flask were then poured into a 100-cubic-centimeter beaker and the flask washed out with five cubic centimeters of water. The combined solution, which was free from humin and needed no decolorization, was brought to pH 3.5 by means of 5N sodium hydroxide added dropwise with stirring. The solution was then diluted with 0.1N hydrochloric acid to a volume such that each cubic centimeter of solution represented one to two milligrams of original nails. Cystine was then determined by the Sullivan colorimetric method, as applied to the quantitative estimation of cystine in casein[2], and in the case of twenty normals and eighty arthritics by the Okuda[4] iodometric method.

The normals varied from 10.28 to 13.02 per cent. with an average of 11.69 per cent. The arthritics varied from 7.20 to 13.11 per cent. with an average of 9.77 per cent. The same relative findings between normal nails and arthritic nails were obtained with the Okuda method which closely agreed with the results by the Sullivan method.

The distribution of the percentage of cystine is shown in Table I.

Twenty-two per cent. of the arthritics showed below 9 per cent. cystine and 57 per cent. showed below 10 per cent. cystine.

The lowest normal gave 10.28 per cent. cystine in his finger nails.

TABLE I

DISTRIBUTION OF THE PERCENTAGE OF CYSTINE

Normals: Cystine Content Per Cent.	Normals: No. of Cases	Arthritics: Cystine Content Per Cent.	Arthritics: No. of Cases
		7.00– 7.99	8
		8.00– 8.99	15
		9.00– 9.99	36
10.00–10.99	2	10.00–10.99	27
11.00–11.99	15	11.00–11.99	7
12.00–12.99	7	12.00–12.99	9
13.00–13.99	2	13.00–13.99	1

Taking this figure as a comparison, 65 per cent. of the arthritics are lower, with a general average of 9.08 per cent.

Since the medical profession has several different systems of classification of types of arthritis, the work dealing with the cystine content of the finger nails covers arthritis as an entity, with suspension of judgment as to whether the particular individual is of the infective, atrophic, or hypertrophic type.

From the data gathered, it is obvious that in the majority of arthritic cases listed here the cystine content of the finger nails was considerably below the normals employed by us. All the normals and all the patients were of the white race, domiciled for some years in the United States. The finger-nail clippings of both normals and arthritics were collected in the same way. Before clipping, the nails were cleaned out with a nail file or by dry brushing, if necessary, but were not washed with water or soap.

SULPHUR THERAPY

Acting on the theory that injurious material reactive with sulphur was present in the arthritic economy, six cases with low cystine content in the finger nails were given a sulphur therapy in the form of intragluteal and intravenous injections * of "Sulfur-Diasporal" †. The results are given in Table II.

Mr. G., a relatively mild arthritic, with a normal cystine content of the nails, served as a control. Little variation occurred in his nails as a result of sulphur treatment. Of the other six chosen because of low cystine nails, all gave an increase in nail cystine as a result of the sulphur therapy. The average of the finger nails of these six cases before treatment was 8.67 per cent. cystine; after treatment, 10.78. Four cases showed a marked increase in cystine in the nails. At the same time in these four cases, appreciable improvement occurred in physical condition, according to the statement of Dr. W. P. Argy, who treated the patients clinically. Cases 1 and 2 were treated intravenously, the rest intragluteally. In Cases 1 and 2 the finger-nail clippings were analyzed again

* The injections were made by W. P. Argy, M.D.
† The Sulfur-Diasporal was donated by The Doak Company of Cleveland, Ohio.

two months after the injections were stopped. The nails were still in normal levels, 12.00 per cent. cystine and 11.84, respectively, and the symptoms of arthritis had not reappeared.

TABLE II

THE PERCENTAGE CYSTINE CONTENT OF THE FINGER NAILS BEFORE AND AFTER TREATMENT WITH "SULFUR-DIASPORAL"

Case No.	Patient	Type	Before Treatment	After Treatment	Number of Injections	Clinical Results
1.	Mrs. D	Infective	9.15	12.48	20	Marked improvement
2.	Mr. C	Infective	8.10	11.54	20	Marked improvement
3.	Mr. F	Mixed	9.35	9.88	20	Improvement
4.	Mrs. G	Mixed	7.84	11.10	20	Little improvement
5.	Miss H	Infective	9.75	10.52	10	Some improvement
6.	Mrs. A	Infective	7.95	9.17	10	Improvement
7.	Mr. G	Mixed	11.01	11.24	10	No improvement

Twenty-five of the arthritic cases listed in this paper were patients of Dr. Thomas F. Wheeldon, of Richmond, Virginia, who found that sulphur therapy has a definite place in the treatment of arthritis[5]. The cystine content of the finger-nail clippings from these twenty-five cases, classified by Dr. Wheeldon as of the hypertrophic type, varied from 7.90 to 12.98 per cent., with an average of 9.54 per cent. by the Sullivan method and 9.74 per cent. by the Okuda method. Two of Dr. Wheeldon's arthritic cases showed more than 11.00 per cent. (11.01 and 12.98); the other twenty-three cases varied from 7.90 per cent. to 10.44 per cent., with an average of 9.32 per cent. cystine. One normal from the same source gave 11.30 per cent. cystine in the finger nails.

POSSIBLE INTERPRETATION OF RESULTS

A number of examples could be given to show that in the sulphur metabolism the animal body has a ready, though limited, means of defense. Detoxication seems, indeed, a prominent rôle of the system cystine, cysteine, and glutathione. In the majority of the arthritic cases the low cystine content of the finger nails seems to imply an intoxication factor which draws on the sulphur complexes as, for example, glutathione, and thus diverts the sulphur from its normal channels which would lead to a finger nail containing at least 11 per cent. cystine. The increase of the cystine content of the finger nails of a number of cases of arthritis, after injection of sulphur, implies that the sulphur directly or indirectly, after change by the body, combines with the injurious material and thus spares the normal body sulphur complexes from being diverted. The nature of the injurious material postulated in most of the arthritic cases is still to be investigated by a detailed biochemical study of the blood or better of the urine. At present the effect of various sulphur compounds on the development and chemical activity of certain streptococci is being studied.

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BACILLUS PROTEUS OSTEOMYELITIS OF THE SPINE *

BY SETH SELIG, M.D., F.A.C.S., NEW YORK, N. Y.

Bacillus proteus is usually a harmless saprophyte of the colon-bacillus group, found in air, soil, feces, and urine. Occasionally, it becomes pathogenic and can become an invader of the blood stream secondary to otitic and urinary-tract infections, especially following intra-ureteral instrumentation. Bacteraemia has also followed war wounds and sloughing wounds, such as one sees in paralysis following spinal-cord injuries. The prognosis in cases of bacillus proteus bacteraemia is poor, especially in otitic cases where there is often an associated streptococcus infection.

If otitic cases are excluded, osteomyelitis is an exceedingly rare complication of proteus sepsis. The mastoid is often involved, but that is by direct extension from a chronic middle-ear infection. The writer has been unable to find any record of a previous case of hematogenous osteomyelitis caused by bacillus proteus.

CASE REPORT

J. S.†, male, aged thirty-seven years, was admitted to the Surgical Service of Mount Sinai Hospital, February 23, 1932, with symptoms of left ureter colic. Roentenographic examination showed a shadow in the course of the left ureter at the level of the third lumbar vertebra. Cystoscopy revealed an obstruction of the left ureter at twenty-seven centimeters and an indwelling catheter was inserted. Six days after the cystoscopy, the patient had a chill and a rise in temperature to 105 degrees. Two days later he had another chill and a rise in temperature to 106 degrees. Blood culture at the time of the second chill showed bacillus proteus in one flask. The patient had six chills altogether, and on March 5, 1932, he passed a calcium oxalate stone. All symptoms ceased, and three days later he left the hospital.

On the day of his discharge from the hospital, the patient had a sensation of slight pain in the back of his neck, but was able to move his head freely. On the following day, the pain became more severe and was increased by movement of the head. The next day, the patient went to bed because of the pain, which now radiated to the side of the head and down the right arm as far as the elbow. There had been no chills since leaving the hospital.

On March 14, 1932, the patient was readmitted to the Surgical Service of Mount Sinai Hospital. There was marked restriction of motion of the cervical spine in all directions, including rotation; there was tenderness over the fourth to the seventh cervical vertebra; and there was some weakness of the right grip. Temperature on admission was 103.5 degrees and the white blood count was 8700 with seventy per cent. polymorphonuclears. A blood culture taken at this time was positive in three flasks for bacillus proteus. A culture of the urine also showed bacillus proteus. A roentgenogram of the cervical spine, taken the day after admission (Fig. 1), showed a definite narrowing of the intervertebral disc between the fifth and sixth cervical vertebrae, as well as loss of the normal curve of the cervical spine.

Five pounds of traction were applied to the head by means of the Crile traction apparatus; pain was relieved almost immediately and temperature fell to normal in the

* Presented at the Meeting of the Orthopaedic Section of the New York Academy of Medicine, May 1932.

† This case was mentioned by Dr. H. Klein[5] in his Addendum, page 195[5].

FIG. 1

Roentgenogram, three weeks after onset of illness (March 15, 1932), shows narrowing of the intervertebral disc between the fifth and sixth cervical vertebrae; also loss of the normal curve of the cervical spine.

FIG. 2

Roentgenogram, eight weeks after onset of illness (April 21, 1932), shows destruction of the bodies of the fifth and sixth cervical vertebrae.

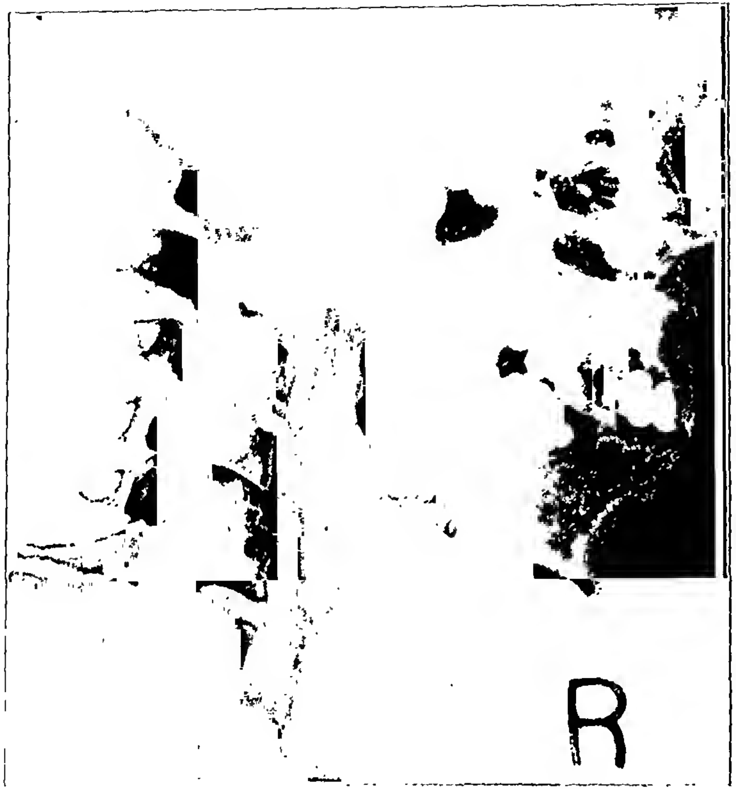

Fig. 3

Roentgenogram, fifteen weeks after onset of illness (June 14, 1932), and after removal of the plaster head spica, shows beginning bony fusion of the bodies of the fifth and sixth cervical vertebrae.

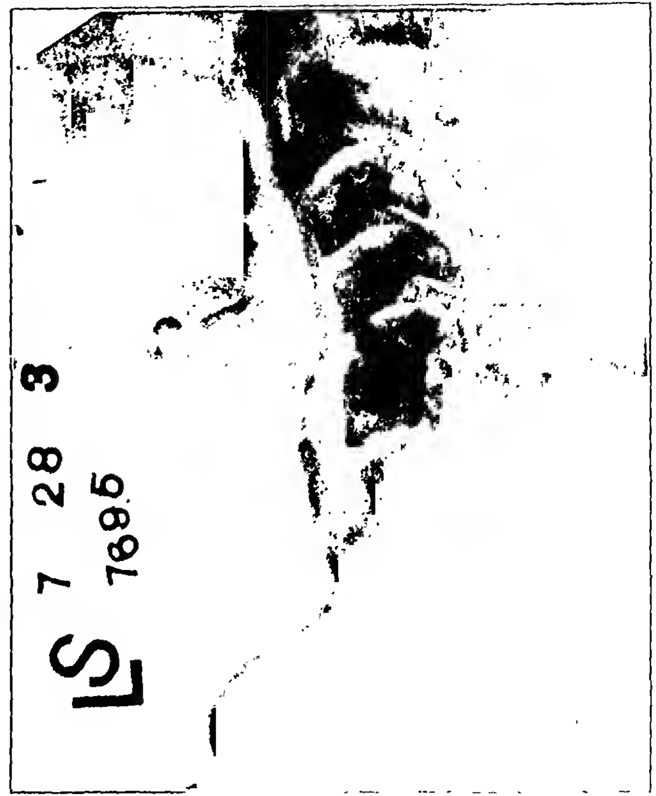

Fig. 4

Roentgenogram, sixteen months after onset of illness, shows complete, solid bony fusion between the bodies of the fifth and sixth cervical vertebrae.

course of the next ten days. On the ninth day after his admission, the illness was complicated by an attack of acute follicular tonsillitis.

On March 30, 1932, physical examination revealed free rotation of the head (atlas and axis), but tenderness over the fifth cervical vertebra and restriction of flexion, extension, and lateral motion of the cervical spine. The patient complained of paraesthesias of the right upper extremity, and there was increased weakness of the right grip.

A roentgenogram, taken April 21, 1932 (Fig. 2), showed well marked osteomyelitis of the fifth and sixth cervical vertebrae, with destruction of the intervening intervertebral disc and collapse of both vertebrae. The patient was quite comfortable in traction, but, because of the danger of subluxation of the diseased vertebrae, a plaster head and shoulder spica was applied. The patient was, however, permitted to leave his bed.

On May 21, 1932, the patient was admitted to Montefiore Hospital for subsequent care. The plaster spica was removed on June 10, 1932. Roentgenographic examination at this time (Fig. 3) showed fusion of the affected vertebrae. There was some restriction of flexion and extension of the cervical spine, and some tenderness over the involved vertebrae. It was thought best to immobilize the spine for several months more in a brace with a jury-mast attachment. This was discarded at the end of six months and since that time the patient has been symptom-free.

A roentgenogram, taken July 28, 1933 (Fig. 4), showed solid bony fusion of the fifth and sixth cervical vertebrae. The density of the diseased area was the same as that of the healthy vertebrae above and below. There was slight restriction of motion of the cervical spine at the extremes of flexion and extension.

SUMMARY

A case is reported of metastatic hematogenous infection of the bodies of two cervical vertebrae during the course of a bacillus proteus bacteraemia following cystoscopy. After prolonged immobilization, recovery took place with solid fusion of the two diseased vertebrae.

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END RESULTS OF FRACTURES OF BOTH BONES OF THE FOREARM

BY HORACE K. SOWLES, M.D., BOSTON, MASSACHUSETTS

From the Fracture Service of the Massachusetts General Hospital

The fractures of the shaft of the forearm considered in this report consist of a group of 120 cases on ninety-one of which we have completed end results.

The great majority of the patients were either children or young adults, the greatest number falling in the second decade, which included forty-six, and the next greatest number in the first decade, in which there were twenty-six. There were eighty-one males and thirty-nine females in the group.

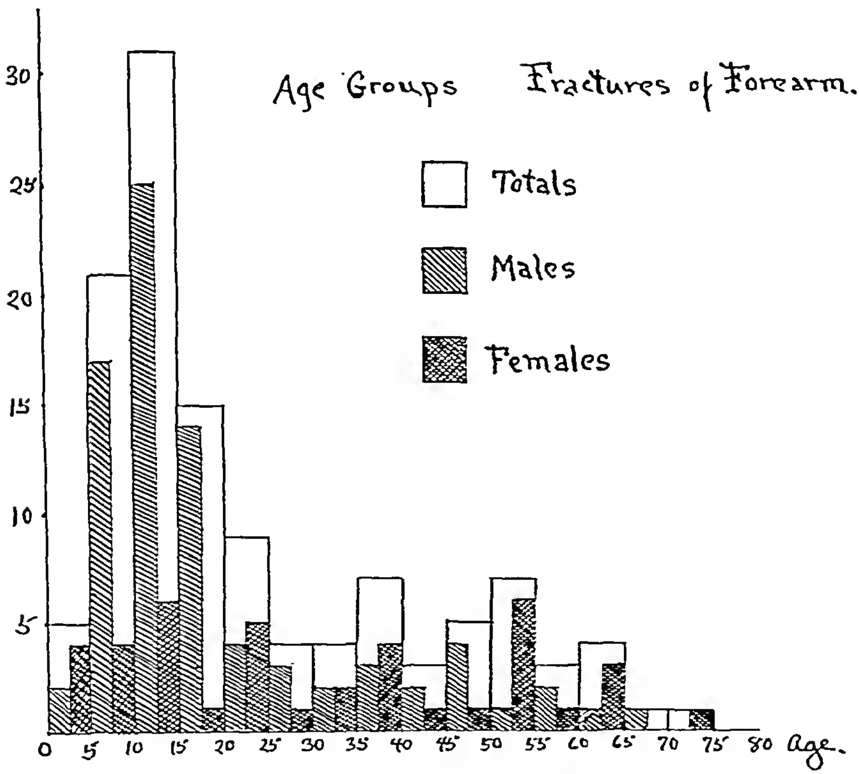

FIG. 1

In regard to the type of injury, there were 100 simple fractures which were divided as follows: eighty-one fractures of both bones, thirteen fractures of the radius only, and six fractures of the ulna only. There were twenty compound fractures. Of these, seventeen involved both bones;

one involved the ulna only; and one simple fracture of the radius was complicated by a compound dislocation of the lower end of the ulna.

TYPES

1. Simple	100	2. Compound	20
a. Both bones	81	*a.* Both bones	17
b. Radius only	13	*b.* Radius only	0
c. Ulna only	6	*c.* Ulna only	2
		d. Radius (simple) and compound head of ulna	1

Considering only the cases in which the end results are known, forty-four were treated by means of closed reduction only; two were treated by traction only, and seven were treated by open reduction only. Four cases which were treated with traction had been treated previously by one or more unsuccessful attempts at closed reduction. Twenty-one cases that came to open reduction had been subjected to previous attempts at closed reduction. Seven cases with open reduction were treated by means of traction also; in some of these cases the traction had been an unsuccessful attempt at reduction and in other cases the hand was suspended by traction in order to facilitate ease of dressing, following an open reduction for compound fracture. Six cases which came to open reduction had previously been subjected to both traction and manipulation unsuccessfully. There were in all fifty cases which were treated without open reduction and forty-one which came to operation.

TREATMENT

1. Closed reduction only	44	2. Non-operative	50
Traction only	2	Operative	41
Open reduction only	7	*a.* Without internal fixation	27
Closed reduction and traction	4	*b.* With internal fixation	14
Closed and open reduction	21		
Traction and open reduction	7	Total	91
Closed and traction and open	6		
Total	91		

It is only fair to explain that this group of ninety-one in which forty-five per cent. have come to open reduction does not represent all the fractures of both bones of the forearm treated at the Massachusetts General Hospital during this period. It represents the ninety-one cases out of 120 admitted to the wards on which we have final end results and does not include 302 fractures of the forearm which were successfully reduced in the Emergency Ward and followed in the Out-Patient Department.

The first group, which consists of those treated by closed reduction with or without the fluoroscope and then the application of plaster or splints, needs very little further explanation. These were successful cases and needed no further consideration. Any treated by closed reduction, which were not successful, automatically fell into one of the next groups.

The second group includes those treated with traction. They may have been treated with traction at once or following one or more unsuccessful attempts at manipulation. In applying traction to the forearm, we have used several different methods. Traction by means of a canvas glove which is glued or sewed around the base of the hand is quite satisfactory. In such traction apparatus the fingers are not included; the fingers of the glove are split on the flexor and extensor sides and used as points of attachment for the traction; and the fingers of the patient are free to move without interfering with the apparatus.

Traction on the fingers themselves has been entirely discarded in fractures of the forearm because of the stiffness in the phalangeal joints which is so prone to follow and so troublesome to cure. Adhesive traction may also be used on the skin of the forearm but this is not quite as easy to adjust as the glove.

Skeletal traction may be used on the forearm but it is not particularly adaptable to that situation. We have tried the ice tongs on one case of forearm fracture in this hospital. This particular case had a badly lacerated hand with traumatic amputation of the thumb and index finger, a badly comminuted fracture of the forearm with considerable laceration of tissues, and a compound fracture dislocation of the upper end of the radius. There was no way in which we could suspend this arm except by using ice tongs on the lower end of the ulna and radius. This fulfilled the purpose of suspension perfectly, but the lateral pressure in the tips of the ice tongs caused a convergence of the lower fragments of the ulna and radius, so that the position obtained was not satisfactory; and the ice tongs were abandoned as soon as the wounds were healed sufficiently so that dressing could be looked after in other ways.

Since this particular case, the use of the Kirschner wire has been introduced and probably at the present time, in such a case, a Kirschner wire through the lower ends of ulna and radius would be used instead of the ice tongs. There is one fact to be kept in mind when a wire is passed through the lower ends of the ulna and radius, — as a result of it, there may be interference with future rotation of the forearm and the wire should be far enough above the wrist so that it will not interfere with the lower articulation of the radius and ulna.

The traction method of treating fractures of both bones of the forearm may be attempted successfully in only a relatively small number of cases. We have had a few strikingly successful results with traction when applied to fractures of the upper third. It is almost useless in fractures of the lower third, because of the cross pulls of the interosseous muscles and tissues. This method takes a good deal of time and fuss for adjustment, but is much safer than open reduction in inexperienced hands or when proper facilities are not available for an open reduction.

In the group of cases that were treated by means of an open reduction, many had already been through one or more attempts at closed reduction and a few had also been subjected to unsuccessful attempts at

traction. As a result of our experience in these cases and in the light of the end results, we believe that one should not lose too much time before making the decision to go ahead with open reduction. In other words, if one or two attempts at closed reduction have been unsuccessful and it seems reasonably sure that an open reduction will be necessary to obtain a good result, then the open operation should be done without unnecessary delay. When the open operation has been delayed for some time after the original injury, it has been more difficult to set the bones together perfectly, particularly in regard to the proper rotation of the arm. If the fracture is reasonably fresh, the jagged ends of bone can easily be fitted into their proper niches in the other fragment and we are sure of the correct rotation, but it is a most difficult thing to decide on the correct position of the hand unless we have these fresh bone ends to guide us, and undoubtedly this one factor is responsible for some of our poorer results of open operation on the forearm.

There is also another very important reason for early open operation,—if the bones can be locked into their correct position, internal fixation of the fragments is rarely necessary and it is desirable to avoid such introduction of foreign bodies unless necessary. With this fact in mind, the writer believes that the best position for doing an open operation on both bones of the forearm is with the patient lying face down, and with the forearm extended palm down upon a table beside the operating table. Then both bones can be reduced through separate posterior lateral incisions, the fragments can be locked in their proper positions, each one can be inspected without disturbing the other, and the wounds carefully closed without disturbing the position of the hand. Then, still keeping slight traction on the hand, a plaster splint can be applied from the axilla to the fingers, with the arm fully extended. In this way we can usually succeed in preventing any slipping of the fragments. After ten days or so, the upper part of the plaster can be cut away in order to allow flexion of the elbow and fixation at a right angle. It may not always be possible to get a perfect apposition of both bones and usually a perfect apposition of one bone will give good enough apposition in the other. In such cases, where it may be possible to get only one bone in perfect position, it is, perhaps, more important to get a perfect position of the radius, because we must maintain the proper length of this bone in order to prevent distortion of relations at the carpus.

In the cases of open reduction, where it is impossible to hold fragments without some form of internal fixation, we have used a variety of fixation material. Sometimes in a spiral fracture, merely a heavy ligature of catgut passed around the shaft will hold the fragments in approximation; or holes can be drilled through the ends of the bones and either catgut or kangaroo tendon used as a suture material. Either one of these materials, of course, has the advantage that it is absorbable within a relatively short period of time. We have also used both ivory and beef bone as fixation material. Ivory or beef-bone pegs inserted in the medullary

cavities have been used in one or two cases; at least one of these resulted in non-union, which may or may not have been due to the ivory peg. Probably a better way of using this type of material is the use of a thin wedge of cortical beef bone, which is driven into longitudinal saw cuts in the ends of the two fragments and acts as a sort of key to hold them in proper position. Both the medullary pegs and the wedges driven into saw cuts give only a moderate degree of fixation and must be handled with great care during the application of the external fixation. Also, both the ivory and the beef bone, although absorbable, do persist for a long time in the tissues. In one case, traces of a thin beef-bone wedge were visible by x-ray after two years.

The method of internal fixation with greatest security is, of course, a Sherman steel bone plate with transfixion screws. We feel that these plates should always be removed, particularly in this location, because they are relatively near the surface of the body and, therefore, subject to possible trauma and irritation. In spite of the fact that the use of steel bone plates necessitates a second operation for their removal, they are most satisfactory and are invaluable in certain types of fractures which cannot be held in place by any other method. Probably all kinds of foreign bodies, which may be used as material for internal fixation, do cause some delay in the bony union; but this cannot be avoided and, although they may cause delay in union, they are rarely, if ever, an important cause of non-union.

Of the forty-one cases in this series which came to open operation, twenty-seven had no internal fixation and fourteen had some form of internal fixation. In the total series of end results, the period of disability ranged from three weeks to two years, the average being about three and a half months. Seven cases out of the series of ninety-one have been classified as bad results. Four of these had open reductions, which, out of a series of forty-one, makes ten per cent. Three of the seven had been treated by closed reduction which, out of a series of fifty, makes six per cent.

End Results

41 Operative Cases
 4 bad end results—10 per cent.
50 Non-Operative Cases
 3 bad end results—6 per cent.

In arriving at this figure, all the cases in which either the anatomical or the functional end-result rating had fallen below three (seventy-five per cent.) have been arbitrarily classified as bad. These bad results may or may not be attributable to the treatment used. They include, for instance, cases of non-union, synostosis, and gross destruction of tissue at the time of injury. It is interesting to note that, in spite of a low rating on the anatomical and functional side, nearly all of these have received a normal economic rating. The reports of these seven cases, classified as bad end results, are briefly as follows:

Case 1. Male, aged fifty-one. July 29, 1924. Caught in a machine belt. Admitted to Massachusetts General Hospital the same day. Simple, transverse fractures of both bones of the left forearm, middle and lower thirds.

July 9, 1924: Closed reduction under gas unsatisfactory.

August 4, 1924: Glove traction, good alignment.

End result: sixteen months. Synostosis, no rotation, stiff fingers, weak grip. He has not worked since the accident. Gets compensation. Anatomical 2 (50 per cent.), Economic 1 (25 per cent.), Functional 1 (25 per cent.).

"Compensitis" and synostosis probable explanation of this bad result.

Case 2. Female, aged twenty-four. April 20, 1930. Automobile accident. Admitted to Massachusetts General Hospital the same day. Simple fracture of both bones of left forearm, middle third, with overriding.

Complications: Fractured clavicle, multiple fractured ribs, multiple lacerations and abrasions.

Treatment: Closed reduction. Plaster applied with arm straight. Good position but no callus at the time of discharge.

End result: one year. Slight limitation of pronation, non-union, and pseudarthrosis of the ulna. Anatomical 2 (50 per cent.), Economic 4 (100 per cent.), Functional 3 (75 per cent.). Excellent reduction; non-union unexplained.

Case 3. Male, aged forty-eight. July 20, 1925. Caught in a pulley. Admitted to Massachusetts General Hospital the same day. Simple transverse fracture of both bones of left forearm, middle third.

Complications: A persistent positive Wassermann.

Treatment: Closed reduction. Ulna good, radius off. Glove traction unsatisfactory. Two weeks later, open reduction; fixation with ivory keys in grooves. Six months, delayed union. Fifteen months, no union in the ulna. Works with a leather splint.

End result: four years. Working, but still non-union of the ulna. Piece of dead bone, sequestrum, acting as a foreign body between the ends. Wassermann still positive; still being treated for syphilis. Anatomical 1 (25 per cent.), Economic 4 (100 per cent.), Functional 4 (100 per cent.). Uncontrolled syphilis probably a factor.

Case 4. Male, aged nineteen. August 7, 1925. Automobile accident. Admitted to Massachusetts General Hospital after seven weeks. Simple oblique fracture of both bones of both arms. One arm was all right. Treatment of other arm had been delayed because of septic hand. Sent to the Massachusetts General Hospital for malunion. One week later, open reduction.

End result: fourteen months. No rotation, non-union, but working and does not want any further treatment, which was advised. Anatomical 1 (25 per cent.), Economic 4 (100 per cent.), Functional 2 (50 per cent.). Bad end result and non-union, probably due to early malunion and late attempt at correction.

Case 5. Female, aged sixty. March 20, 1930. Fell on her hand. Admitted to Massachusetts General Hospital the same day. Compound, comminuted transverse fracture of both bones of left lower third of forearm.

Treatment: After two weeks, open reduction. Fragments of radius removed and bone plated. Ulna shortened one-half inch and sutured with kangaroo tendon. Plate out after ten months.

End result: twenty-five months. Non-union, but improving. Anatomical 2 (50 per cent.), Economic 4 (100 per cent.), Functional 4 (100 per cent.). Non-union, probably due to loss of bony tissue.

Case 6. Female, aged forty-eight. June 26, 1924. Automobile accident. Admitted to Massachusetts General Hospital the same day. Simple comminuted fracture of both bones of right forearm, middle and upper thirds. Closed reduction unsatisfactory. Glove traction unsatisfactory. Then splints. Traction again later with good alignment.

End result: eighteen months. Non-union of the ulna, poor position of the radius, motion limited. Anatomical 2 (50 per cent.), Economic 4 (100 per cent.), Functional 3 (75 per cent.). Non-union unexplained.

CASE 7. Male, aged forty-five. September 8, 1924. Motorcycle accident. Admitted to Massachusetts General Hospital after four days. Compound comminuted fracture of both bones of middle third of left forearm with overriding.

Complications: Compound fracture of femur, old ununited fracture of neck of femur, fracture of lower end of right radius and ulna.

Treatment: Glove traction unsatisfactory. Two weeks later open reduction, bone plate. Bone plate out in one month.

End result: two and one-half years. Disabled two years, no rotation, stiff fingers, synostosis. Anatomical 2 (50 per cent.), Economic 3 (75 per cent.), Functional 2 (50 per cent.). Severe accident, long disability in extremely arthritic patient only apparent explanation.

Finally, there are just one or two pitfalls in connection with fractures of the forearm which should be pointed out. If we find a fracture of the shaft of the ulna with shortening, we are almost sure to find either a fracture or a dislocation at the head of the radius; and, if we find a fracture of the shaft of the radius with overriding, there is almost sure to be a fracture or dislocation of the lower end of the ulna. In both of these cases, open reduction is indicated, for the fracture of the shaft must be very accurately reduced in order to maintain the proper length of the forearm. Otherwise the patient is sure to have trouble from distortion of the elbow articulation in one case, and from distortion of the carpal articulation in the other. Distortion of the carpal articulation is also prone to occur when there is a shortening of either bone due to loss of substance. This is particularly troublesome if there is any shortening of the radius.

TUBERCULOSIS OF THE SPINE

A Study of One Hundred Cases

BY Z. B. ADAMS, M.D., BOSTON, MASSACHUSETTS

The following results are from a study of 100 cases of tuberculosis of the spine treated at the Lakeville State Sanatorium between 1928 and 1932, or received from other hospitals for convalescent treatment following operation.

Of the 100 cases, there were fifty-six adults and forty-four children or young adults who had never done any work. Of the fifty-six adults, the aggregate time spent in the hospital amounted to 75.75 years; the aggregate time of sickness before entering the hospital was 215 years.

Three of these cases were readmissions:

1. A case of lumbar Pott's disease with fused bodies, but with persisting sinuses.
2. A case of tuberculosis of the spine, kidney, and elbow, pulmonary tuberculosis, and syphilis, but the patient left the hospital in good condition.
3. A case of active pulmonary tuberculosis with sacro-iliac and lumbar caries, and with abscess. The patient died after 1,781 days (practically five years) at Lakeville. This patient had had lumbar Pott's disease with abscess for eight years before entering the hospital.

Skin reactions were positive in ninety-eight and absent in two. Two of the ninety-eight reacted to bovine, but not to human tuberculosis.

In addition to the vertebral lesion, there were the following tuberculous complications:

Site	*No. of Cases*	*Site*	*No. of Cases*
Hilum	9	Eye: cornea	1
Lungs	22	Eye: conjunctiva	1
Kidney	7	Knee	1
Bladder	1	Sternum	1
Lymph glands	3	Ulna	1
Ankle	2	Fingers	1
Hip	7	Wrist	1
Elbow	2	Jaw	1
Peritoneum	1		

In some instances, two of these additional foci were present in the same case.

Sixty-one operations were performed on fifty-nine of the 100 patients as follows: twenty-nine at the Lakeville State Sanatorium; seventeen at the Massachusetts General Hospital; two at the Children's Hospital; one each at several other hospitals. Thirty-eight of the sixty-one operations

were performed on adults and twenty-three on children (two of the children were under two years of age). Four of these fifty-nine patients died. The operations performed on these four patients were as follows:

1. Double-graft operation performed on the spine of a child; patient died of fat embolus.
2. A laminectomy performed on an adult at Lakeville State Sanatorium.
3. A graft operation performed on an adult at Trumbull Hospital, following a previous graft operation at the Graduate Hospital in Philadelphia.
4. An osteoperiosteal-graft operation performed on an adult at the Massachusetts General Hospital.

Thirty-seven of the 100 patients had sinuses; twelve of these died, three are still in poor condition, and twenty-two have recovered.

Of the fatal cases, twenty-one patients had had direct contact with cases of tuberculosis.

Twelve of the 100 patients were in poor condition on entry. Of these twelve, nine died. One, who was in poor condition on entry but in good condition at the time of operation, died of a fat embolus and status lymphaticus. Of the other three patients, two of whom were children, one child is in good condition and one child and one adult are in fair condition.

Of the six children with sinuses, three had sinuses directly from the spine and three from other foci. None of these six children have died. Of the adolescents (twelve to twenty years of age) with sinuses, eight had sinuses from the spine; five of these patients died and three recovered. Of the twenty-three adult patients with sinuses, six had sinuses from some other focus than the spine. Seven of these twenty-three patients died and in one of the seven cases the sinus was not from the spine. Sixteen patients recovered. Of the patients with sinuses, the highest mortality occurred in adolescents. Four of the patients with sinuses had amyloid disease; of these, three were adults and one an adolescent.

There were nine deaths among the forty-four children and twelve deaths among the fifty-six adults. In these twenty-one fatal cases no operation was done except the opening of an abscess and the four operations listed. Fourteen of these twenty-one fatal cases had sinuses. The causes of death were amyloid disease, pulmonary tuberculosis, meningitis, tuberculous kidney, hip disease with sinuses and enteritis.

Of these twenty-one fatal cases, sixteen patients had disease in the lumbar region and five in the dorsal region. The disease in the dorsal cases was extensive and low,—one extending from the sixth to the twelfth vertebra; one from the sixth to the eleventh; one involving the eighth, ninth, and tenth vertebrae; and one the eleventh and twelfth; and the mid-dorsal case in which the patient died of fat embolus. This shows that tuberculous disease of the lower spine is more often fatal.

TUBERCULOSIS OF METATARSAL BONES

Report of a Case

BY PAUL E. McMASTER, M.D., LOS ANGELES, CALIFORNIA
AND ROBERT W. KING, M.D., CHICAGO, ILLINOIS

From the Department of Surgery, Division of Orthopaedics, of The University of Chicago

Tuberculosis of the long bones of the feet is seen quite infrequently in children and is even more rare in adults. Of 254 cases of bone and joint tuberculosis (174 in children and 80 in adults) seen in the University of Chicago Clinics, only two cases involving the metatarsal bones have been encountered. The case of a sixty-year-old male, who had had neither a previous history nor physical findings of tuberculosis, is reported here. The second case was that of an eight-year-old colored boy with tuberculosis of the elbow and bilateral involvement of the first metatarsals of the feet.

FIG. 1
The destructive changes present in the distal end of the first metatarsal bone were misinterpreted and a diagnosis of chronic osteomyelitis rather than tuberculosis was made.

A white male, sixty years old, entered the Clinics in August 1930, complaining of a painful right foot. Four months previously he had noticed a painless swelling in the region of the first metatarsal. This increased in size and after several days pain developed which later became constant. There was no history of injury, loss of weight, or fever.

General physical

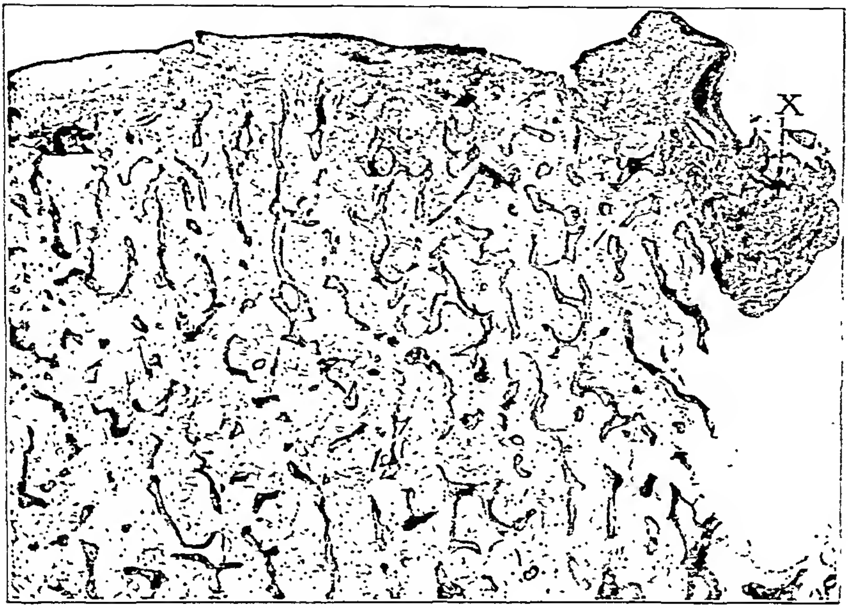

FIG. 2

Tuberculous granulation tissue is seen destroying the marginal articular surface and undermining the central articular cartilage. Discrete tubercles (X) with giant cells are seen in the granulation tissue at the periphery. The marrow spaces are mostly fatty and numerous dead cells are present in the bony trabeculae.

examination upon admission to the Clinics was essentially negative. There was slight swelling in the region of the first metatarsal bone and adjacent phalanx. The mass was soft but not fluctuant. Pressure on the first metatarsal or weight-bearing produced pain.

Urinalysis, white-blood-cell count, temperature, red-blood-cell count and hemoglobin were normal. Wassermann was negative. A roentgen ray taken at this time is shown in Figure 1. A diagnosis of osteomyelitis was made and a partial ostectomy performed.

Microscopic studies of the osseous tissue removed showed a mild chronic inflammation but no evidence of tuberculosis.

The patient was discharged from the hospital a week following the operation. He returned in two months complaining of pain and a persistent draining sinus at the operative site. Roentgen rays taken at this time showed a progression of the lesion with further involvement of the distal end of the bone and destruction of the joint margin. A diagnosis of tuberculous osteomyelitis was made.

At the second operation in January 1931 the distal two-thirds of the bone was excised. Grossly the peripheral portion of the articular cartilage was destroyed but partly preserved in the central portion.

Microscopic sections made sagittally through the bone showed tuberculous granulation tissue destroying the articular cartilage at the periphery and extending subchondrally across the central part of the bone (Fig. 2). Typical tubercles were found in the granulation tissue at the margins. Proximal to the distal end, the marrow spaces were invaded only a short distance by the granulations. The bony lamellae contained numerous dead cells and the marrow spaces were largely filled with fatty tissue and smaller amounts of fibrous tissue. There was a moderate lymphocytic invasion and a few scattered polymorphs were present.

The wound healed *per primum* and the patient was discharged from the hospital two weeks following the operation. He was fitted with a longitudinal and transverse

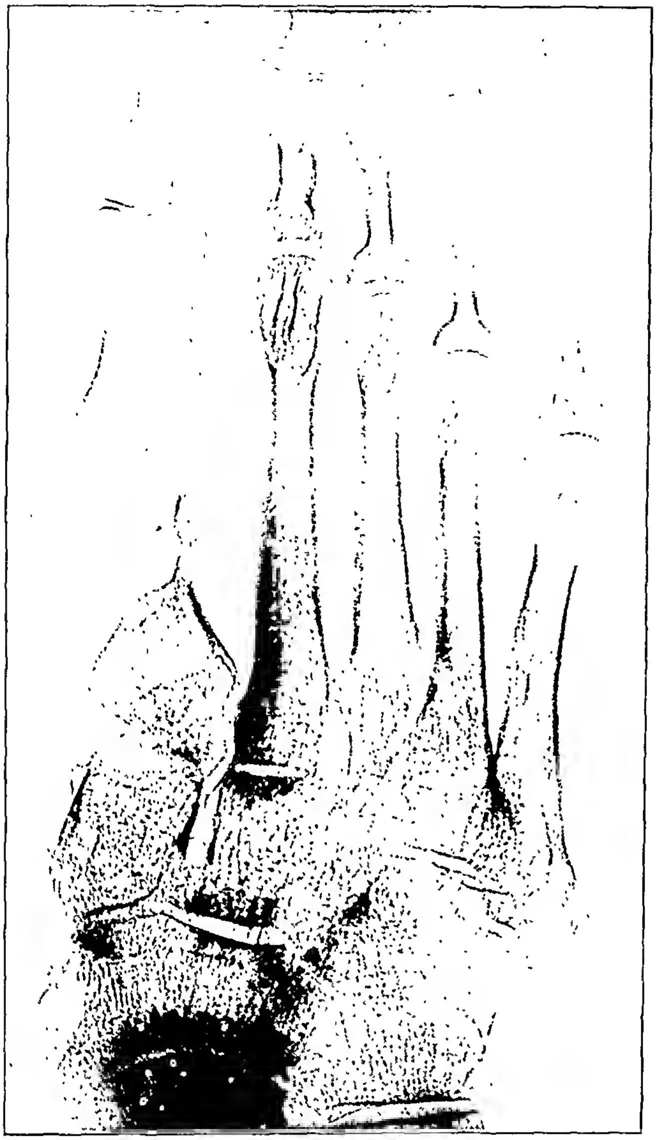

FIG. 3

Roentgen ray taken one year after resection of the distal two-thirds of the first metatarsal. The bony spicule on the stump apparently resulted from periosteal proliferation or a fragment of bone left behind at the time of operation. This caused no pain. Note the decreased density of the large toe phalanges.

arch support after four weeks and instructed to start bearing some weight on the foot. Four months after the operation he was feeling fine and having no difficulty with the use of the foot.

Examination one year after the operation showed the big toe to be somewhat retracted, but he was having no pain. Roentgenograms (Fig. 3) disclosed a spicule of bone extending distally from the stump. This growth apparently took place from a portion of periosteum or fragment of bone which was left behind at the time of operation.

Two years after the second operation the patient, who had been carrying on a normal existence and having no trouble with his foot, contracted pneumonia and died.

Besides the relative rarity of the above reported condition it is interesting to note that after resection of the distal two-thirds of the first metatarsal bone, this patient had a useful and painless foot, with the aid of a transverse and longitudinal arch support. The "bony atrophy of disuse" present in the first toe phalanges, as shown in Figure 3, suggests that this toe was little used in walking.

The pathological findings here—namely, granulation tissue, tuberculous at the region of synovial reflection, but non-specific in the subchondral areas, and destruction of peripheral cartilage—correspond to observations made of tuberculous arthritis in other joints.

A SIMPLE METHOD OF APPLYING A BODY CAST IN FRACTURES OF THE SPINE

BY JARRELL PENN, M.D., KNOXVILLE, TENNESSEE

The application of a plaster-of-Paris body cast with complete extension of the spine sometimes offers considerable difficulty in a general hospital where such apparatus as a Goldthwait frame or similar appliances to facilitate application are not available. The following method has proven quite satisfactory, and may be employed in any hospital that has a Hawley table.

When the time arrives for the application of the cast the patient is removed from the fracture bed or Bradford frame, the hyperextended position being maintained by a sandbag or firm pillow placed under the lumbar region; the patient is put on the carriage, and is taken to the operating room. In transferring him to the Hawley table the hand is passed under the pillow and the patient is lifted to the table, pillow and

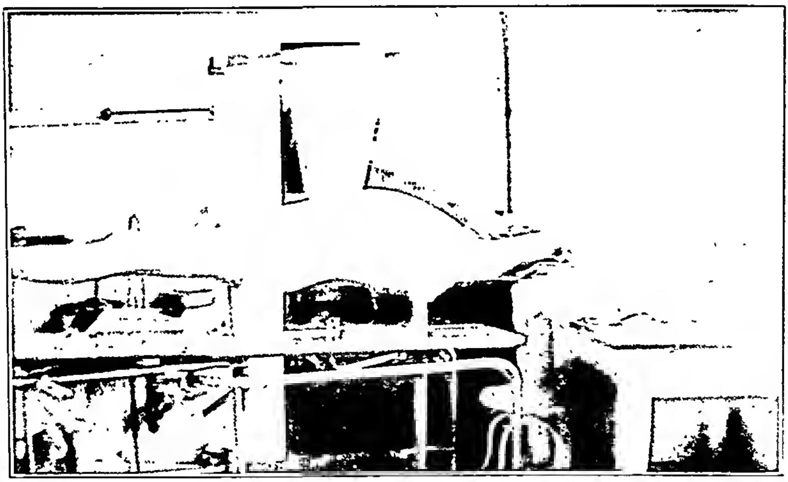

FIG. 1

all, thus maintaining his position. The perineal post and overhead bars are applied and the latter are swung around to point towards his head, thus overhanging his body. The feet are fastened to the foot pieces. Stockinet having been previously applied to his body, a piece of domestic folded to two or three thicknesses, six or eight inches wide, is placed next to the stockinet under the lumbar region. It is brought out on the other side and both ends are fastened snugly by safety pins to the overhead bars, thereby making a convenient sling. A thick layer of sadler's felt completely covering the back is placed over this. The movable portion of the Hawley table is then dropped and the patient's position is main-

tained by the feet, sacral support, the sling, and the shoulder support. The body cast is now applied and reenforced as necessary.

After the body cast has been applied, the domestic is cut on one side flush with the cast and is easily pulled out on the other side, as it is not incorporated in the cast but is next to the felt. The apertures left by the presence of the sling are of sufficient size to allow the operator to place his hand firmly on the stockinet on the side which has been cut short, in order to prevent wrinkling when the sling is pulled out, and, should minor wrinkles occur, they can easily be straightened out through these apertures. After the sling has been removed the openings left by its removal are closed with plaster-of-Paris.

This method of application is comfortable to the patient and any degree of extension desired is easily maintained.

USE OF A MODIFIED HOSPITAL BED FOR TREATING FRACTURES OF THE SPINE

BY ROBERT F. PATTERSON, M.D., KNOXVILLE, TENNESSEE

It is usually imperative to secure immediate hyperextension of the spine in cases of crush fractures of the vertebrae, to prevent cord pressure. It often happens that the proper apparatus for securing hyperextension—such as the Rogers extension appliance, properly prepared Bradford frame, or other suitable apparatus—is not immediately at hand if one is working in a general hospital. It is also true that all such appliances need more or less constant adjustment to keep them in place and to make them comfortable.

Recently confronted with such a situation in the case of a badly crushed vertebra, the author made use of an ordinary hospital bed,—the kind that can be raised at the head and buckled up at the knees in order to support the patient's legs in a flexed position. By reversing the patient and placing his head at the foot of the bed, the convex surface was utilized to hyperextend the spine.

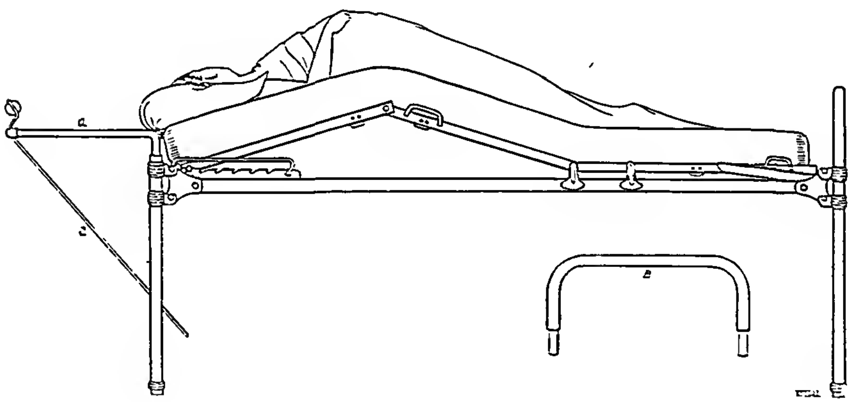

FIG. 1

A. Removable malleable gas-pipe extension.
B. Sawed-off portion of bed with cores inserted.
C. Pulley fastened to rod for temporary head extension.

The bed is prepared as follows: The hollow, curved portion, extending above and across the foot of the bed, is cut off even with the lateral bars. A quadrilateral extension is made of malleable piping, the proper size to fit into the inside of the hollow ends of the sawed-off posts. About four inches of each end is bent to a right angle to fit into the ends of the sawed posts on the bed. A tube of canvas is slipped over the extension to fill in the interval. The angle of the extension can be changed by simply bending the ends as desired. On this the patient's head rests.

The sawed-off portion of the bed is preserved and into it are driven

two cores large enough to fit snugly into the sockets. This can be replaced on the bed when the extension is removed and the bed used again for general hospital purposes.

A firm mattress is necessary. Additional extension is secured by increasing the convexity. Wooden blocks of different sizes are used to slip in to hold the convexity until the first "catch" on the bed is reached.

Should head traction be necessary a pulley is easily fastened to the end of the extension frame.

This procedure has been used in two cases with complete satisfaction.

AN IMPROVED SHOE LIFT *

BY C. W. GOFF, M.D., HARTFORD, CONNECTICUT

To balance the pelvis, where one leg is shorter-than-the-other, has always required an appliance which has been more or less unsatisfactory. At The Newington Home for Crippled Children, an old application has been rejuvenated combining all the requirements of such a shoe.

It is made from two pieces of cork which are the proper height and shaped to fit the sole. The original sole of the shoe is left in place and the cork is glued to it with shoemaker's glue. This joins the two pieces of cork directly under the center of the longitudinal arch of the foot which

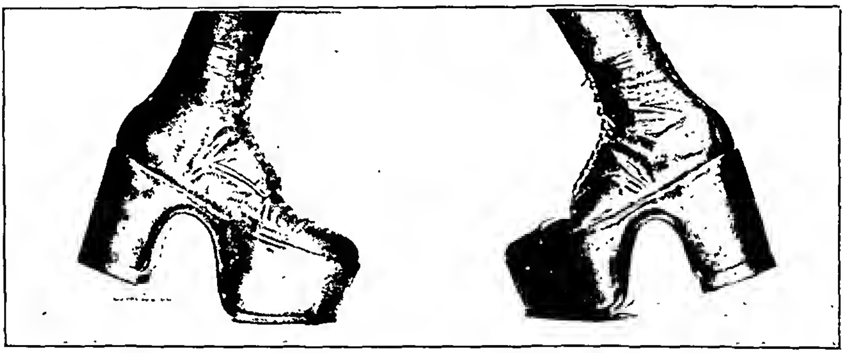

FIG. 1

An improved orthopaedic lift, made of cork, heel and sole separated, covered with thin leather, and soled with heavy elastic leather.

has been cut very high in the manner shown in the cut. The sides of the cork are then covered with thin black leather, and a special piece of thick, very flexible leather is modeled when damp to the sole and arch of the entire cork surface. Thus the arch is constructed to produce great flexibility between the sole and the heel.

When such a shoe is worn, the rocking from heel to sole is done in a perfectly natural manner. The elasticity of the thin portion of the sole just under the longitudinal arch allows for this ease. When stepping onto the toes of the foot, the heel portion bends upward.

It has been our experience that the usual solid sole, not allowing for a flexible longitudinal arch in the shoe, very rapidly wears out either the stocking on the sides of the heel or the leather or cloth lining of the shoe on the inside of the heel portion of the shoe. This is, of course, caused by the constant friction set up when the foot tugs to pull away from the heel portion as the patient rises on his toes. A solid cork sole does not

* From the Orthopaedic Service of R. M. Yergason, M.D., The Newington Home for Crippled Children, Newington, Connecticut.

permit this spring to the sole. In this design of shoe, the separate sole and heel with the heavy elastic leather sole covering permits a greater ease of action and makes walking a much more comfortable process.

This type of shoe is an old and tried principle, but we believe sufficient emphasis has not been brought to bear upon the covering of the sole part with a pliable sheet of leather. A flexible shank always has a distinct advantage over an inflexible one. A rubber heel can be added to further promote elasticity and comfort.

AN ATTACHMENT FOR HAWLEY FRACTURE TABLE

Designed to Facilitate Application of Body Casts

BY CHARLES K. PETTER, M.D., OAK TERRACE, MINNESOTA

From the Orthopaedic Department, Glen Lake Sanatorium, and Department of Surgery, University of Minnesota Medical School, Minneapolis

To facilitate the application of high body casts and shoulder spica casts a simple attachment for the Hawley fracture table has been designed and serves admirably.

The body is supported upon a long pair of Goldthwait irons, bent to conform to the curves of the spine. These irons are in turn supported by a modification of the regular sacral rest and an especially designed head piece, as illustrated in Figure 1.

The small sacral rest, standard equipment with the Hawley table, was cut down, leaving just enough to support the irons, each held in place by a pin. The head is semicircular with pins in the cross piece to allow different distances between the irons at the head end, and has a post and pin to hold it in the position of the regular head and shoulder support.

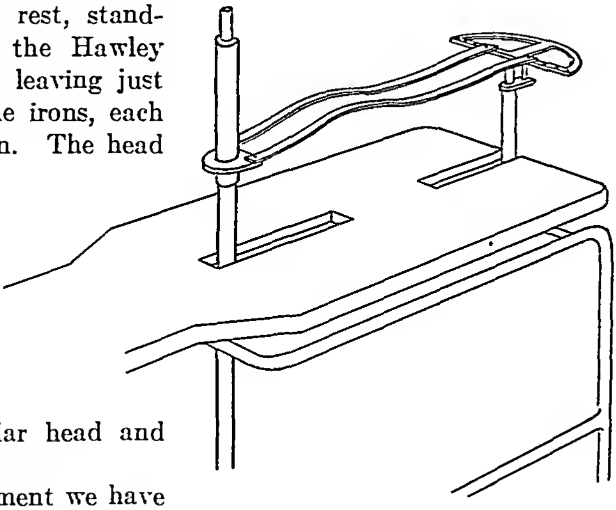

Fig. 1

With this attachment we have been able to produce body and shoulder spica casts much more satisfactorily and with greater ease than without it. The parts are easily fashioned by a good machinist at a very small cost.

The mechanical assistance of Mr. Allen Dean in constructing this appliance is hereby acknowledged.

NEW METHOD OF ATTACHING KNEE CAP TO CALIPER TYPE OF BRACE WITH LOCK KNEE JOINT BY MEANS OF SWIVELED LEVERS

BY FRANCIS S. CHAMBERS, M.D., ELIZABETHTOWN, PENNSYLVANIA

Pennsylvania State Hospital for Crippled Children

The addition of a lock knee joint to a brace of the caliper type adds much to the convenience of the patient, but usually impairs the efficiency of the appliance. This is due to the difficulty in obtaining a satisfactory adjustment of the knee cap.

The leather knee cap is usually attached to the leg and thigh uprights by means of straps. If it is adjusted tightly over the knee with the leg extended and knee joint locked, the brace functions as a good caliper, providing maximum stability for standing and walking; but, unless the adjustment is altered, the patient will find it inconvenient to bend the knee after unlocking the knee joint, because the knee cap will become tighter as flexion is increased. As a result, a "compromise" adjustment is usually employed, the knee cap being worn too lax for maximum stability and still too tight for comfortable flexion.

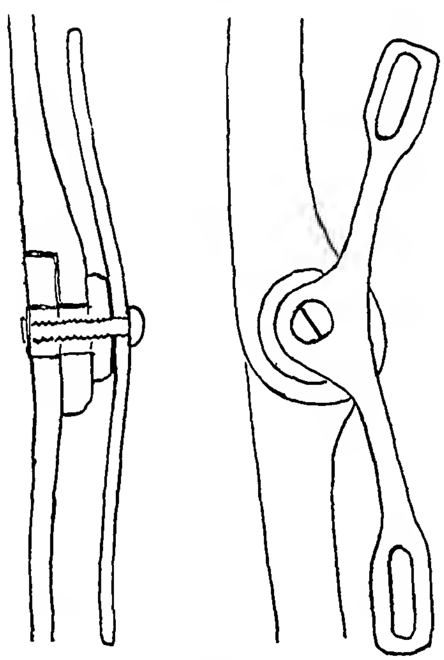

Fig. 1

If the knee cap straps are attached to swiveled levers, which are

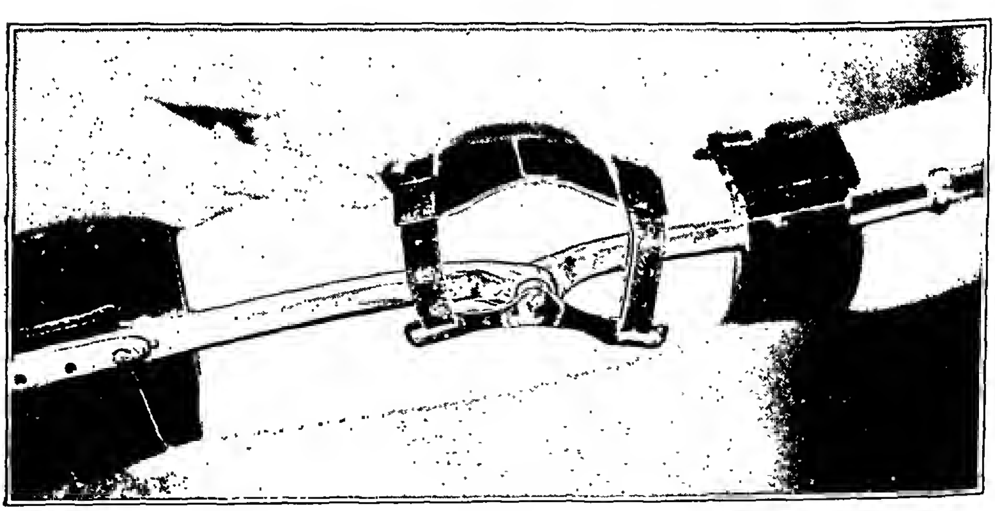

Fig. 2

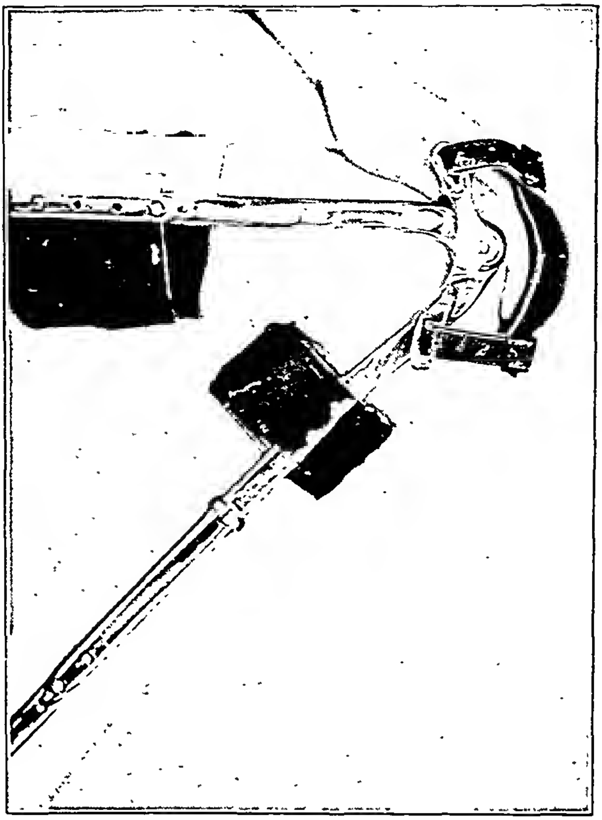

FIG. 3

pivoted at the knee joint rivet, as illustrated, these difficulties will be overcome. The knee cap can be adjusted as tightly as desired with the leg extended; flexion will at once release tension of the knee cap and the patient will be able to fully bend the knee in comfort.

The illustrations show the manner in which the knee cap is attached to a lock knee-joint brace by means of swiveled bars. The lock knee-joint rivet is drilled completely through to receive a threaded screw which forms the rivet for the swiveled lever (Fig. 1). The swiveled levers should be so designed that the lower arm will be a trifle longer than the upper.

Figure 2 and Figure 3 show the device applied to a lock knee-joint brace worn by a girl with extensive paralysis of the lower extremity. In Figure 2 it will be seen that the knee cap is too tight to permit her to introduce her finger beneath it. Figure 3 shows full flexion: the knee cap has become so loose that she can pass her hand beneath it.

The writer has been using this little device for over a year. It has added considerably to the comfort and efficiency of our patients dependent upon braces equipped with lock knee joints.

Acknowledgment is made to Mr. Hans Christoph, Philadelphia, for his help and cooperation in fashioning this useful device.

News Notes

The Journal prend beaucoup de plaisir à envoyer aux éditeurs de *La Presse Médicale* ses félicitations pour l'édition de luxe qui marque le quarantième anniversaire de la fondation de cette publication. Les éditeurs ont présenté à leurs lecteurs un numéro scientifique et en même temps artistique. Nous leur souhaitons le succès continuel qui leur est dû.

The second annual meeting of the **American Academy of Orthopaedic Surgeons** will be held in the Palmer House, Chicago, on January 7, 8, 9, and 10, Dr. W. E. Campbell, President. A very full and attractive program is offered. Seminars and symposiums are planned for some of the most important subjects in which the surgeons are interested,—such as neurological and circulatory aspects of especial value to the orthopaedic surgeon, bone pathology, bone tumors, and fractures. In addition to these there will be papers on a large number of subjects. Mr. Naughton Dunn, of Birmingham, England, is to present a paper on "Stabilization Operations in Poliomyelitis with Especial Reference to Feet". The annual banquet is to be on Tuesday, January 9.

The fourth **Sir Robert Jones Lecture** was given at the Hospital for Joint Diseases, New York City, on Thursday evening, November 23. The lecturer was Dr. Melvin S. Henderson of the Mayo Clinic and President of the American Orthopaedic Association. His subject was "Surgical Conditions of the Knee Joint".

The practice of the late Dr. Emil S. Geist is being continued by Dr. Vernon L. Hart, formerly of the Division of Orthopaedic Surgery of the University of Michigan and the Dayton Clinic, whose present address is Medical Arts Building, Minneapolis, Minnesota.

At a recent meeting of the **Nordisk Ortopedisk Förening** held in Stockholm the following members of the British Orthopaedic Association and of the American Orthopaedic Association were elected foreign members:

A. S. B. Bankart, M. C., F.R.C.S., London
H. A. T. Fairbank, D.S.O., C.B.E., London
Harry Platt, M.S., F.R.C.S., Manchester, England
E. G. Brackett, M.D., Boston, Massachusetts
M. S. Henderson, M.D., Rochester, Minnesota
Robert B. Osgood, M.D., Boston, Massachusetts

The Robert Jones Orthopaedic Club met in Baltimore on Thursday, Friday, and Saturday, November 2, 3, and 4. On Thursday the session was held in the Hurd Memorial, Johns Hopkins Hospital, on Friday at the Children's Hospital School, and on Saturday at the James L. Kernan Hospital for Crippled Children. On each of these days a large number of interesting demonstrations and cases were shown by the members.

The fifteenth annual meeting of the **Société Française d'Orthopédie** was held in Paris on October 13, 1933. The following subjects were considered at this meeting:

1. Open Reduction of Congenital Dislocation of the Hip. M. Mutel, of Nancy.

   Dr. Mutel agrees with the majority of authors whom he cited that the indications for the open reduction are definitely limited (eight per cent. of the

irreducible dislocations in the young). In the older subjects he gives preference to the less radical operations, such as osteotomy or the placing of a shelf.

2. Chronic Vertebral Arthritis. A. Richard, of Berck.

The **Fourth International Congress of Radiology** will be held in Zurich, July 24–31, 1934, under the presidency of Prof. Dr. H. R. Schinz. The President of the Swiss Confederation will open the Congress on July 25. At this meeting Prof. Gösta Forssell will report on the organization of the cancer campaigns in general. Other speakers will report upon the measures in their own countries. A more extended program of the meeting will appear in the next issue of *The Journal.*

The Fall meeting of the **Michigan Orthopaedic Society** was held in Detroit, September 18, 1933. Members present were: Drs. Badgley, Blodgett, Curtis, Hodgen, Kidner, Peabody, Purcell and Steifel. The chief subject for discussion was Public Act 236, which allows for care of all indigent crippled children in the State.

The following officers presided:

President: Dr. F. E. Curtis
Vice-President: Dr. C. W. Peabody
Secretary: Dr. F. H. Purcell

The Twenty-Eighth Congress of the **Deutsche Orthopädische Gesellschaft** was held in Leipzig on September 11, 12, and 13 under the presidency of Prof. Fr. Schede. The three principle subjects for discussion were: (1) Orthopaedics and Rheumatism, by Prof. Veil, of Jena, and Prof. Klinge, of Leipzig; (2) Flat-Foot in Children and Adults, Especially in Regard to the Prophylaxis, the discussion of which was opened by Prof. Bormann, of Leipzig; and (3) The Development of the Construction of Artificial Limbs Since the War, by Prof. zur Verth, of Hamburg. The remainder of the meeting was given to the discussion of various subjects by members of the Association. The meeting in 1934 will take place in Dortmund with Prof. Brandes as president.

The Annual Meeting of the **Pacific Northwest Orthopaedic Society** was held in Portland, Oregon, September 16, 1933. The program included clinics and scientific papers. Clinics were held in the Shriners' Hospital by Dr. Richard B. Dillehunt, Dr. Charles R. McClure and Dr. Leo S. Lucas; in St. Vincent's Hospital by Dr. Harry C. Blair; and in Good Samaritan Hospital by Dr. Otis F. Akin and Dr. C. Elmer Carlson, all of Portland.

Papers were presented by Dr. Alfred O. Adams and Dr. William E. Grieve of Spokane, Washington; and by Dr. Roger Anderson, Dr. Joe Brugman, Dr. John F. LeCocq, Dr. D. A. Murray, and Dr. H. J. Wyckoff of Seattle, Washington. At the annual business meeting following the banquet at the University Club, Seattle, Washington, was selected for the 1934 meeting. The officers for the ensuing year are: Dr. D. A. Murray, President; Dr. M. C. Lile, Vice-president; and Dr. J. C. Brugman, Secretary-Treasurer, all of Seattle, Washington.

The meeting of the **Clinical Orthopaedic Society** was held in Rochester, Minneapolis, and St. Paul on November 10 and 11, 1933. One hundred and thirty-two members were present at an unusually successful meeting and the clinical material was presented in general by the members residing in Rochester, Minneapolis, and St. Paul. On November 10 the meetings took place at St. Mary's Hospital and the Mayo Clinic, in Rochester, and, on November 11, at the University of Minnesota, Minneapolis, and Gillette State Hospital for Crippled Children, St. Paul. The annual banquet was held in Minneapolis on November 10.

The following were elected to membership in the Society:

P. A. Bendixen, M.D., Davenport, Iowa

Leo F. Miller, M.D., Chicago, Illinois
W. G. Stuck, M.D., Rochester, Minnesota

The officers for the ensuing year are:

President: E.B. Mumford, M.D., Indianapolis, Indiana
Vice-President: E. S. Hatch, M.D., New Orleans, Louisiana
Secretary-Treasurer: J. E. M. Thomson, M.D., Lincoln, Nebraska

It was voted that the meeting for 1934 should be held in Dallas, Shreveport, and Houston.

The Interurban Orthopaedic Club met in Boston and Providence on November 3 and 4.

On the morning of the third, demonstrations were given at the Massachusetts General Hospital and at the Children's Hospital. At the Massachusetts General Hospital, Dr. M. N. Smith-Petersen demonstrated an operation for internal fixation of fracture of the femur with the end results, including the successful treatment of non-union of subcapital fractures in people of advanced years, the anatomical and functional results being practically perfect. At the Children's Hospital, Dr. Albert Brewster showed some excellent results in cases of paralysis of the deltoid in which there had been a transplantation of the biceps or triceps tendon.

In the afternoon, at the Lakeville State Sanatorium the end results of cases of spinal and hip fusion were shown by Dr. Z. B. Adams, a report of which is published elsewhere in *The Journal*.

On the morning of the fourth, the Club met in Providence with Dr. Murray Danforth who presented an outstanding demonstration of the course of the disease, the treatment, and the end results of three cases of Calvé-Legg-Perthes disease. The treatment consisted of three years of rest in bed without the use of a splint or apparatus. A large number of roentgenograms, taken at intervals from the early stages of the disease to the final results, showed in each case at the present time the reestablishment of the epiphysis in its normal shape and bone density. Physical examinations of the patients showed that they had practically no limitation of movement in any direction. The demonstration certainly suggested the wisdom of considering whether it would not be well to treat cases of this disease by this method in order that a better shaped epiphysis in old cases might permit the patient to escape the disability so common in the adults who have had this disease.

At the meeting of the **Section of Orthopaedic Surgery of the New York Academy of Medicine**, on Friday evening, October 20, 1933, the chairman, Dr. Paul C. Colonna presided.

Dr. Isadore Zadek demonstrated a case of enormous cysts of the popliteal spaces in which there was communication of the cyst with the knee joint from one side but not from the other. He also presented a case of extra-articular fusion of the hip joint which gave rise to considerable discussion in regard to the best angle of ankylosis. It was generally agreed that abduction beyond ten degrees rarely gave a satisfactory gait, but that a neutral position or slight adduction resulted satisfactorily.

Dr. Leo Mayer showed a case demonstrating the effectiveness of treatment of paralytic calcaneus without astragalectomy. It was demonstrated that satisfactory posterior displacement of the foot could be secured by the removal of bone from the neck of the astragalus and from the scaphoid.

Cases were also shown by Dr. Mather Cleveland and Dr. David M. Bosworth.

In the paper of the evening, "Some Observations in European Clinics", Dr. Clay Ray Murray emphasized the differences between American and Continental orthopaedic surgeons,—the more conservative tendency of the European as contrasted with the more radical operative methods of the American. The Continental surgeon tends to leave to time and the innate power of the patient many things which the American attempts to solve by surgical methods. There also appears to be a marked difference in the point of view of both patient and physician as to what characterizes a satisfactory result. The

time element seems to be of little importance abroad where the patients of the clinic type yield unquestioning obedience. Unfortunately, the foreign clinics are faced with even more acute financial problems than the American, preventing them from purchasing adequate apparatus.

The Joint Meeting of the **Orthopaedic Section of the New York Academy of Medicine** and the **Philadelphia Orthopedic Club** was held on Friday, November 17, 1933. The afternoon session was held at the Hospital for Ruptured and Crippled and the evening session at the New York Academy of Medicine.

Dr. Arthur Krida showed the results of the use of a fascial transplant, not only illustrating the effectiveness of the method, but also the danger, since the patient had a persistent equinus of 100 degrees.

Dr. Nicholas Ransohoff presented a series of anatomical preparations which demonstrated the fact that the crucial ligaments could be severed by interfering with the other ligaments of the knee and that section of the anterior crucial ligament had no effect when the calf was extended, but with considerable anteroposterior motion in flexion of the knee, which was increased with double division of the crucial and the lateral ligaments.

Dr. Joseph L'Episcopo in his discussion called attention to the fact that the crucials were in tension only in the positions of extreme flexion and extension.

Papers were presented in the evening by Dr. A. Bruce Gill and Dr. J. Torrance Rugh, of Philadelphia. Dr. Gill strongly advocated arthrodesis in cases of intracapsular fractures of the neck of the femur, which had gone on to non-union and Dr. Rugh called attention to the association of peculiar knee-joint symptoms in three unusual cases.

Cases were also demonstrated, or papers read, by Dr. Lewis Clark Wagner, Dr. James Toumey, Dr. Paul Colonna, Dr. M. Beckett Howorth, Dr. Albert Ferguson, Dr. L. E. Snodgrass, Dr. Joseph Buchman, Dr. Alan DeF. Smith, Dr. Samuel Kleinberg, and Dr. Armitage Whitman.

Dr. Royal Whitman gave an address on the evolution of orthopaedic surgery in America.

The **Annual General Meeting of the British Orthopaedic Association** was held in Edinburgh on November 24 and 25, 1933, at which the following subjects were discussed:

Some Points in the Clinical Aspects of Bone Pathology. Mr. David M. Greig.
Osteitis Fibrosa. Mr. J. W. Struthers, Prof. A. Murray Drennan, and Mr. C. P. Stewart.
Lipoidgranulomatosis of Bone. Prof. John Fraser.
Some Disorders of the Forefoot. Mr. John Bruce.
Sciatica Considered in Relation to Correlated Variations in the Lumbar Spine and Lumbosacral Plexus. Mr. W. A. Cochrane.
Sacralization: a New Method of Approach for the Surgical Treatment. Mr. Walter Mercer.
Observations on the Pathology of Congenital High Shoulder and Arthrogryposis Multiplex Congenita. Mr. D. Stewart Middleton.
The Findings of a Biochemical Examination of Hematoma Fluids from the Sites of Fractured Bones, with Some Clinical Applications. Mr. Robert I. Stirling.
Fractures of the Carpal Scaphoid. Mr. H. Osmond Clarke.

The Association Dinner was held in the Hall of the Royal College of Physicians on Friday evening, November 24.

The following officers were elected for 1934:

President: Harry Platt
Vice-President: P. Jenner Verrall
Hon. Treasurer: S. L. Higgs
Hon. Secretary: E. P. Brockman

Editorial Secretary: G. Perkins
Executive Committee: W. A. Cochrane
S. A. S. Malkin
T. P. McMurray
W. R. Bristow

The following were elected to membership in the Association:

Full Members

Mr. V. H. Ellis, 5 Park Square West, London, W. 1.
Mr. B. H. Burns, 19 Upper Wimpole Street, London, W. 1.
Mr. J. B. Colquhoun, Melbourne Children's Hospital, Frankstone, Victoria, Australia.

Associate Members

Mr. Alex Millar, Victoria Infirmary, Glasgow.
Mr. D. J. Martin, 50 Sedlescombe Road South, St. Leonards-on-Sea.
Mr. J. S. M. Robertson, 13 Grosvenor Terrace, Glasgow, W. 2.
Mr. H. A. Pask, Wrightington Hospital, Wrightington, Nr. Wigan.
Mr. C. A. Calvert, 35 University Road, Belfast.
Mr. McKellar Hall, 244 St. George's Terrace, Perth, Western Australia.
Mr. H. A. Brittain, Newmarket Road, Norwich.
Mr. D. C. Mackenzie, St. Vincent, Tain, Ross.
Miss E. Grierson, Bretby Hall Orthopaedic Hospital, Nr. Burton-on-Trent.

Honorary Member

Dr. Max Böhm, Bayreutherstr., 38, Berlin W. 62, Germany.

Just as the last form of *The Journal* goes to press comes the sad news of the death of Dr. Charles F. Eikenbary. Dr. Eikenbary died in Seattle on December 31. A more extended notice will appear in the next issue of *The Journal*.

Current Literature

RÖNTGENDIAGNOSTIK DER KNOCHEN- UND GELENKKRANKHEITEN (X-Ray Diagnosis of Bone and Joint Diseases). By Prof. Dr. Robert Kienböck. Vienna, Urban & Schwarzenberg, 1933. Heft 1, 8.50 marks; Heft 2, 7.60 marks.

Two volumes of this work have already appeared. The first, *Differentialdiagnose der Geschwulstigen Knochenkrankheiten,* is a terse monograph of 103 pages with twenty-six illustrations, covering the entire subject of bone tumors. The classification is somewhat different from the usual and is well adapted to clinical use. The material is well arranged for quick reference. For each type of tumor there is: an outline of the clinical findings; an outline of the x-ray findings; and a summary, including the differential diagnosis, prognosis, and treatment.

The second volume, *Knochenechinokokkose,* is an exhaustive monograph of eighty-five pages on echinococcus infection of bone. It is as detailed as the first volume is brief. Cases from the literature are reviewed and tabulated. An additional case is reported in the minutest detail. This patient was observed over a twenty-four-year period during which the pelvis and much of the femora and spine were gradually destroyed.

THE SCIENCE OF RADIOLOGY. Edited by Otto Glasser in collaboration with well known scientists. Springfield, Illinois, Charles C. Thomas, 1933. $4.50.

This is a compact volume of twenty-five chapters, comprising less than 500 pages. It presents an adequate history of the development of the science of radiology from the discovery of the roentgen ray thirty-eight years ago to date and the manner in which it was received by the world at large. It follows step by step the work of the American pioneers, discussing briefly their contributions.

A general survey of the physics of the roentgen ray is given, as well as an outline of the development of x-ray apparatus and a picture of the amazing progress in the development of tubes, recording media, screens, and the measurement of dosage. The chapter on "Radiological Diagnosis" is a fine synopsis of the great advance made possible in medical and surgical diagnosis, including the outstanding contributions of the many men in this field.

Each chapter contains a brief but complete description of a particular and important phase of roentgenological endeavor, with an extensive and valuable bibliography. "Military Roentgenology" is a résumé of the work done by American roentgenologists during the World War. The book is distinctive and entirely worth while.

FRACTUREN UND LUXATIONEN. By Prof. Dr. Georg Magnus. 2 Aufl. Berlin, Julius Springer, 1933. 3.60 marks.

Under the above title, the author has produced a booklet which, as he states, is intended for the student and the practitioner. The material is divided into two parts: (1) a discussion of the general aspects of fractures and dislocations, such as the mechanism of production, clinical features, complications, process of healing, and disturbances of normal repair; (2) a discussion of special types of fractures and dislocations, including those of the head, trunk, and upper and lower extremities.

The forms of injury mentioned and described by the author are, as a rule, only those which are more commonly seen. The descriptions and outlines for treatment are, however, sufficiently clear and complete to serve as valuable guides in the proper management of the conditions. Technical details of the treatment are not included, although the indications for the methods of therapy to be employed are very clearly emphasized. The principles here advocated for the management of injuries can be safely followed, and, accordingly, the book may well be recommended for the purpose which it is meant to serve.

LES ARTHRODÈSES DANS LA COXALGIE. By Paul Bufnoir. Paris, Masson et Cie., 1933. 20 francs.

Dr. Bufnoir has made a particularly valuable study of this subject, especially as it is directed toward the determination of the final results of this procedure, and after a sufficiently long interval to estimate the actual anatomical and functional results. Few operations require so long an interval to determine the true value, for there are many relapses and a long convalescence, even after a favorable early postoperative period. The tendency of the almost universal application of this operation in cases of tuberculous hip disease has been in some sections of the world very pronounced, although the need of intelligent selection of cases and proper stages of the disease has been strongly advocated by many surgeons of large experience.

The cases studied were practically all from the Service of Prof. Sorrel at the Maritime Hospital at Berck and many were traced and given personal observation and examination after their return to their homes.

In this book the author has considered hip disease as divided into three stages, each of which has been given special consideration as regards its fitness for this operation,—the early stage, the stage of evolution or development, and the final or quiescent stage. He has reported on seventy-five cases studied by personal observation. On thirty-seven of these patients operations were performed in the stage of evolution,—twenty-nine on adults and eight on children. He finds that this operation is rarely indicated in children at this stage and discusses the results in children and also in adults in whom the operation in this stage is much more favorable. He then studies the results of arthrodesis in the later conditions of the disease, dealing with the sequelae of hip disease. In this series the adults and children are not separated, but the cases are considered as a whole. The postoperative conditions met with are described, as well as the type of operation, the functional and anatomical results, the fate of the graft, etc. He also discusses the relative value of the different types of technique advocated by various authors.

The author has given a very valuable presentation of the subject from a conservative, although not too conservative, point of view, as one would expect from such a thorough study of the actual end results of this large series of operations. A short history of each of the seventy-five cases, including the final results, is given, as well as many x-rays showing the original and final condition of the hip in the different series of cases. A subject so thoroughly considered certainly will have the endorsement of the medical profession.

ENTSTEHUNG, ERKENNUNG UND BEHANDLUNG DER FERSENBEINBRÜCHE (The Etiology, Diagnosis, and Treatment of Fractures of the Calcaneus). KNOCHENBRÜCHE UND UNFALLCHIRURGIE IN IHREN BEZIEHUNGEN ZUR UMWELT (The Social Aspects of Fractures and Traumatic Surgery). By Dr. Lorenz Böhler, Vienna, Wilhelm Maudrich, 1933.

The fourth edition of Dr. Böhler's book (four editions in five years) differs from the third only in the extensive rewriting of the chapters on fractures of the calcaneus and on the relationship of traumatic surgery to society. These chapters appear in monographic form with the above titles.

The subject of fractures of the calcaneus has been expanded from six pages, in the first edition, to thirty-two pages in the fourth edition. Four years of additional experience and a careful review of all of the writer's cases have tempered his early claims. This chapter is now a complete presentation of the subject, flavored with a frankness which is refreshing. Particularly interesting is his autobiographical sketch of mistakes in the development of his present technique. More valuable, even, is a list summarizing eighteen errors to be avoided in treating these difficult fractures.

The second monograph is an interesting mixture of warnings to the industrial surgeon, suggestions for improvement of the organizations handling injured workmen, and the history and present management of the Industrial Hospital of Vienna. It contains much information that should be valuable to the industrial surgeon.

ORTHOPÄDISCHE GYMNASTIK. By Prof. Dr. Med. Georg Hohmann and Lina Stumpf. Leipzig, Georg Thieme, 1933. 7 marks.

This book on orthopaedic exercises, dedicated to a healthy German race, contains 156 pages and is divided into five parts: Round Back, Lordosis, Flat Back, Scoliosis, Motion Disturbances of the Upper and Lower Extremities.

Each part is treated separately. A good general description and an analysis of treatment are followed by excellent illustrations, most of which are schematic line drawings.

The book, as stated in the preface, is written for the physician as well as for the technician, who, under the necessary guidance, can easily carry out the various procedures.

In dealing with the problem of scoliosis, the multiplicity of factors responsible for the affliction are comprehensively shown and followed by the statement, *"die Scoliosengymnastic noch nicht soweit durchgebildet ist, wie es wunschenswert wäre"*.

The book is well balanced and written in a clear and comprehensive style.

LES TRAUMATISMES FERMÉS DU RACHIS. By G. Michel, M. Mutel, and R. Rousseaux. Paris, Masson et Cie., 1933. 50 francs.

The authors have given in this book a very excellent presentation of the subject of fractures of the spine, both with and without cord and nerve involvement.

They have considered the separate regions of the spine—the cervical, dorsal and lumbar, and lumbosacral—with the special characteristics which are found in each, both in the anatomy and in the injuries of these special regions. In the first part of the book the authors have presented a chapter on the anatomy and physiology of the individual vertebrae, as well as the different regions of the spinal column and of the spine as a whole, including the separate vertebrae, all of which serves to explain much of the mode of occurrence and the character of many injuries peculiar to the different portions of the spine.

The sections dealing with the examination of clinical symptoms and signs are also considered with reference to the different regions which are also divided into the cervical, dorsal and lumbar, and lumbosacral regions, including the special types of injury with the clinical signs and symptoms peculiar to each region. In this discussion the atlas and axis, and also the fifth lumbar, with its association with spondylolisthesis, are given special consideration, in addition to the other injuries generally found in these three regions.

A large part of the work is devoted to the subject of compression fractures of the vertebrae, and the various types of fracture of the individual bodies, showing the distribution of the line of fracture and compression, are also described and shown by excellent illustrations.

The nerve anatomy and physiology are described with reference to their bearing and treatment, which gives valuable aid to the diagnosis and localization of injury in the different regions. These are illustrated by excellent diagrams of the distribution of the nerve structures, both cord and nerve trunks, which are found in the injuries in various parts of the spinal column. In the chapter on treatment, the different methods of treatment of fractures, both with and without nerve injury, are discussed—the conservative and the radical or the rapid methods of reduction, as well as the immediate and the late operative procedures—and their relative values are compared.

Much has been written in recent years on this subject, particularly with reference to the modes of treatment, which have been the outgrowth of the improvement in examination, particularly by the x-ray, and the increasing recognition of the frequency of these injuries, as well as their response to treatment. The authors have been able to profit by these recent investigations and published information, and have been able to add to this their own personal experience. The book is an excellent statement of the present knowledge and opinions on this important subject.

KLINIK DES CHRONISCHEN RHEUMATISMUS. EIN BUCH FÜR DIE PRAXIS. By Dr. Med. Paul Schober. Stuttgart, Ferdinand Enke, 1933. 6.20 marks.

The author of this work has spent seventeen years at Wildbad and has seen thou-

sands of cases of chronic rheumatism. The book is written from the viewpoint of the internist.

Several classifications of chronic rheumatism are recorded and a new one is added, according to the author's own conception of the various ailments which may be included under this general heading. This is followed by a description of each of the different types of the disease, dealing mostly with subjective and objective symptoms.

The discussion of the treatment is limited to less than six pages. The most favorable method of therapy is a course of hydrotherapy at Wildbad.

Die Luft- und Fettembolie. By Dr. Med. Siegfried Hoffheinz. Neue Deutsche Chirurgie. Band 55. Stuttgart, Ferdinand Enke, 1933. 37.20 marks.

This book is so developed that each main topic constitutes a volume, the first dealing with air emboli, the second with fat emboli. The subjects are considered in a most detailed manner, with subtitles arranged to afford easy reading.

The volume on air emboli is unimpressing, there being a barrenness of facts. The author states that air emboli are the problem of the general surgeon and the internist doing chest work, and that ordinarily they are harmless, being disposed of by the respiratory organs.

The volume on fat emboli is more conclusive and interesting. The author believes that they are tolerated and safely disposed of in varying quantities in certain individuals, being eliminated in quite large amounts without deleterious effects. Considerable information is offered regarding their preponderance in fracture and bloodless operations. He speaks against such procedures, emphasizing the danger, and is particularly opposed to the types of orthopaedic operations for correction, such as osteoclasis and *brisement forcé*. For treatment of fat emboli nothing definite is offered.

No specific cause for either form of embolus is offered, and no definite cause for death from either form is explained. The author would have his readers conclude that death from either type is the result of a complex,—a complication of catastrophes involving to a greater or lesser degree the lungs, the heart, and the brain.

In this book are compiled the salient points on the subject in medical and surgical literature, with a résumé of authorities. The contents are controversial and expressed opinions are not convincing. It is the summation of opinions, past and present, upon air and fat emboli, but definitiveness by the author is lacking.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Boletines y Trabajos de la Sociedad de Cirugía de Buenos Aires, XVII, Nos. 20–29, 1933.

Bulletin of the National Tuberculosis Association, XIX, Nos. 10–12. New York, 1933.

Bullettino e Atti della Reale Accademia Medica di Roma, LIX, Fasc. 10–11, 1933.

Slovanský Sborník Ortopedický, VIII, Sešit 5. Brno, Czechoslovakia, 1933.

La Tribuna Médica, VII, Nos. 204–209. Havana, 1933.

Programm des 50. Fortbildungkursus der Wiener Medizinischen Fakultät, 1933.

Announcements, University of Chicago, XXXIII, No. 14, Medical Schools Number, 1933.

*Beiträge zur Kenntnis der Traumatischen Epiphysenlösungen an den Langen Röhrenknochen der Extremitäten. Eine Klinisch-Röntgenologische Studie. Ernst Bergenfeldt. (Acta Chirurgica Scandinavica, LXXIII, Supplementum XXVIII.) Stockholm, P. A. Norstedt & Söner, 1933.

Sanocrysin Treatment in Tuberculosis. Karl J. Henrichsen and Henry C. Sweany. (The American Review of Tuberculosis, XXVIII, Supplement to No. 4, October 1933.) Baltimore, National Tuberculosis Association, 1933.

*To be reviewed in a later issue.

Über Dornfortsatzfraktur durch Muskelzug, Insbesondere über sog. Schleuderbruch (Fracture of Spinous Processes by Muscle Pull, Especially the So Called "Throw-Fracture"). Lars Lönnerblad. *Acta Chir. Scandinavica,* LXXIII, 285, 1933.

Nine cases are reported in which ditch diggers and laborers, using shovels or forks, sustained indirect fractures of a spinous process by muscle pull. The seventh cervical vertebra or the first thoracic vertebra was usually involved. The mechanism was fairly constant.

While digging in a deep ditch, often with both feet stuck in the clay, the workman heaves a shovelful over the edge. The sticky clay fails to leave the shovel, however. Its inertia jerks the hand which holds the grip, and imparts a considerable wrench to the back of the same shoulder. The man feels a sudden sharp pain between the shoulder blades, and often a snap. He may return to work after a few minutes, but has increasing pain on the days following.

The anatomical factors are discussed.

When the patient is seen early, there are pain and tenderness at the site of the fracture and crepitus may be elicited. After a few weeks these findings may all be absent. The symptoms are characteristic, however, and the x-ray establishes the diagnosis. Fracture must be distinguished from a persistent, aberrant ossification center and from muscle strain.

Conservative treatment is indicated, with total disability for physical work for one month. The fragment frequently fails to unite. Because of annoying snapping, removal of the loose piece may be indicated, but, in one case in which the operation was performed, this was not successful in relieving pain.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Über Frakturen des Unteren Humerusendes bei Kindern (Fractures of the Distal End of the Humerus in Children). Wäinö Avellan. *Acta Chir. Scandinavica,* LXXIII, Supplementum XXVII, 1933.

Complete with historical summary and comprehensive bibliography, this monograph covers the subject of fractures of the lower end of the humerus in children. Only forty-one cases are studied, but they are reported in the greatest detail with x-rays and follow-up on each case. Loss of motion, changes of length, and loss of carrying angle are tabulated. This study of thirty-one supracondylar fractures, five epicondylar fractures, four fractures of the lateral condyle, and one fracture of both condyles furnishes the basis for numerous conclusions, some of which are as follows:

Following supracondylar fractures, ninety-four per cent of the cases had a loss of motion, averaging 12.5 degrees, and this was most often a limitation of flexion. If a good reduction cannot be obtained by manipulation under anaesthesia, wire extension should be used. Open operations are done only in case of nerve or vessel injury.

Fracture of the medial or lateral condyle and epicondyle require open reduction when the fragments are much displaced or in the joint. The fragment should be nailed exactly in place or sewed back with wire or silk. If this is not possible, or the viability of the fragment is questionable, extirpation is in order. Diacondylar fractures almost always require open reduction.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Protrusio Acetabuli. Nils Silfverskiöld. *Acta Orthop. Scandinavica,* IV, 1, 1933.

Five cases of medical protrusion of the acetabulum are added to the eighty-nine already published. One of these was secondary to tuberculous coxitis, and another to gonorrheal coxitis. In three cases of true Otto pelvis, the onset occurred at the ages of twenty-two, thirty, and twenty years, respectively, and no definite causative factor could be established. The osteo-arthritis which was present was thought to be secondary to the change in the acetabulum.

The deformity can be considered as an entity, the etiology of which is varied and often obscure. In selected cases, especially in young individuals with bilateral involvement, plastic surgery is suggested by the writer, although none of his patients were subjected to operation.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

BONE TUMORS—A GENERAL PRACTICE PROBLEM. Merrill C. Mensor. *Am. J. Cancer,* XIX, 65, Sept., 1933.

The author stresses the importance of scrupulous, exhaustive study in cases presenting persistent bone pain. Roentgenographic examinations may be negative or ambiguous in cases of early bone tumor, and every possible means should be employed to establish diagnosis at an early stage.

The author presents a series of case histories illustrative of several of the types of bone tumors which may be encountered in a general practice. He emphasizes the importance of preserving a hopeful attitude. The article is illustrated with photographs, roentgenograms, and photomicrographs.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

HISTOGENESIS OF EWING'S SARCOMA OF BONE. WITH POST-MORTEM REPORT OF A CASE. Perry J. M. Elnick. *Am. J. Cancer,* XIX, 353, Oct. 1933.

This is a case report with autopsy findings, roentgenograms, and photomicrographs of a case of Ewing's sarcoma of the femur. The author reviews the theories of the histogenesis of the tumor from endothelium or the reticulo-endothelial system, and finds the evidence in support of the theories inadequate. He concludes that the tumor is an undifferentiated round-cell sarcoma, probably originating from mesenchymal cells in the connective tissue of the haversian canals. The paper provides a good bibliography on the histogenesis of these tumors.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

SQUAMOUS-CELL EPITHELIOMA ORIGINATING IN CHRONIC OSTEOMYELITIC CAVITIES. REPORT OF TWO CASES. Pio Blanco. *Am. J. Cancer,* XIX, 373, Oct. 1933.

The author reports two cases of squamous-cell carcinoma originating in chronic osteomyelitic cavities, with photographs and photomicrographs of the specimens. Neither case showed remote metastases, and a cursory search of the literature suggested that in general such tumors are relatively benign as compared with other squamous-cell carcinomata. The author recommends curettage for diagnosis in persistent osteomyelitic sinuses.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

OSTEO-CHONDRITIS DISSECANS. H. A. T. Fairbank. *British J. Surg.,* XXI, 67, July 1933.

The writer believes that trauma to the inner femoral condyle by the tibial spine in internal rotation is responsible for the occurrence of this lesion in the knee joint. He believes that the cause is trauma, pure and simple. He does not accept the embolic theory, the theory that trauma is followed by pathological changes, or the theory that the lesion is inherited.

The typical lesion is a fracture, for these reasons:

1. It usually occurs in adolescents and young adults indulging in vigorous pastimes.
2. Typical lesions are seen in roentgenograms and at operation in cases where there has been definite recent trauma.
3. There is an entire absence of inflammatory change in or about the lesion.
4. At early operation, the appearance is that of a recent fracture. At later operation, the appearances resemble those of normal repair of such a fracture.
5. "When the detached fragment is suspended by a vascular pedicle the bone in it is not dead, and is not a sequestrum, so why should it have been exfoliated?"

Operative treatment is advised in a suspected case. If the lesion is a mild one and the underlying bone is not loose, the cartilage is left alone. If the cartilage is soft and rough, it should be excised. If the cartilage is partly broken off, it should be removed. All loose bodies are removed. The prognosis for some years is good, but there are reasons to believe that osteo-arthritic changes will occur sooner or later.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

Pied Forcé or March Foot. Harold Dodd. *British J. Surg.*, XXI, 131, July 1933.

The literature is reviewed at some length.

The typical clinical findings are a swelling on the dorsum of the foot, centered about the shafts of the second and third metatarsals. It is slightly reddened and tender. There is a palpable bony mass which is callus, associated with a fracture of the shaft of the metatarsal. It may give a suspicion of a bony neoplasm.

The process is found in soldiers, or in others who walk a good deal, bearing heavy packs.

The treatment consists of proper hygienic care of the feet, scrubbing the feet and legs daily in hot water with a soft brush, wearing frequent changes of thick socks, avoiding standing, walking with the toes pointing forward, never walking without shoes, elevation of the feet when sitting down, and exercises for the feet and toes.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

Etiology and Treatment of Slipped Epiphysis of the Head of the Femur. E. N. Wardle. *British J. Surg.*, XXI, 313, Oct. 1933.

Eleven cases are reported, several in considerable detail. The etiology of slipped epiphysis is considered, and it is suggested that either indirect trauma or endocrine disorder produces weakening at the epiphyseal line; displacement then proceeds under the force of body weight.

Treatment by gradual traction in adduction is described and three successful cases are reported in detail with serial x-rays. Traction in abduction is condemned.

Gradual traction is advocated as being the most efficient form of treatment. Subtrochanteric osteotomy is an excellent line of defense, but should be reserved for cases seen when the deformity has consolidated. No case should be allowed to consolidate in deformity without a prolonged trial of traction. Open operation is condemned.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

An Improved Pattern of the Revolving Spinal Bed. E. W. Hey Groves. *British Med. J.*. II, 53, 1933.

Hey Groves describes an improved pattern of the spinal bed first described in 1930 (*British Medical Journal*, I, 66, 1930). It consists of a cylindrical mattress divided into four segments and held in a frame which permits it to rotate about a longitudinal axis. It is useful for the treatment of spinal injuries and spinal operations.—*R. I. Harris, M.B., Toronto, Canada.*

Role of Fusion Operations as Applied to the Hip Joint. Melvin S. Henderson. *British Med. J.*, II, 327, 1933.

Henderson discusses the indications for fusion of the hip joint,—stability in flail hips as a measure in the control of disease (chiefly in tuberculosis of the hip), and for the relief of pain. He discusses the three main types of fusion: extra-articular, intra-articular, and the combined form. The operation used at the Mayo Clinic is described. The results in seventy cases are tabulated, fusion being obtained in 92.5 per cent. of tuberculous joints, 82.3 per cent. of infectious arthritic joints, 100 per cent. of traumatic joints,

50 per cent. of osteo-arthritic joints, and 100 per cent. of the flail hips due to poliomyelitis.—*R. I. Harris, M.B., Toronto, Canada.*

A Paper on the Prevention of Accidents and Complications in the Course of Treatment in Chronic Osteomyelitis. H. Winnett Orr. *British Med. J.*, II, 365, 1933.

This paper by Dr. Orr opened the discussion on osteomyelitis before the Section of Orthopaedics at the Annual Meeting of the British Medical Association in Dublin, 1933.

He discusses the historical development of his now well known method from the treatment of war wounds upon Listerian principles, and then outlines in detail the steps in the applicaton of the Orr treatment of osteomyelitis. The paper appears in condensed form but is printed in full in the reprints.—*R. I. Harris, M.B., Toronto, Canada.*

The Manipulative Treatment of Painful Feet. Philip Wiles. *British Med. J.*, II, 563, 1933.

Painful feet are due to: (1) chronic foot strain; (2) minor deformities, corns, etc.; (3) chronic arthritis. Chronic foot strain constitutes the largest class. Due to weakness of the muscles normally supporting the foot, the strain falls on the ligaments, a few fibers of which are ruptured. The reparative process results in a scar which, when stretched, is painful. This condition can be treated by splinting, so as to prevent strain on the adhesion, or, better, by rupturing the adhesion by manipulation. Manipulation must be carried out carefully, skillfully, and methodically under full anaesthesia. The technique is fully described. Results in 100 cases are recorded and analyzed. The percentage of cures is high.—*R. I. Harris, M.B., Toronto, Canada.*

Beitrag zu den Endergebnissen der Unblutig Behandelten Angeborenen Hüftgelenkverrenkung (Contribution to Study of End Results of Bloodless Treatment of Congenital Dislocation of the Hip). F. Becker. *Deutsche Ztschr. f. Chir.*, CCXLI, 273, 1933.

An analysis was made of sixty-seven cases with ninety-seven dislocations. The method of treatment used was that of Lorenz. Of the cases in which reduction was carried out twenty years previously, the results were poor in seventy-five per cent. and reluxation had occurred in forty per cent. Anatomical cures were obtained in only about one-eighth of the patients. Of those cases in which reduction was accomplished five years previously, anatomical cures were obtained in one-eighth; seventy-five per cent. had excellent function; of these, however, a large number showed, roentgenographically, a mild or severe degree of subluxation which was not apparent clinically. Of this group also, twenty per cent. of the hips were redislocated.

The high percentages of good results are only apparent. Only those cases with anatomical cures have any prospects of a permanent cure; every subluxation, however mild, has the tendency to be aggravated during the years of growth, and may finally lead to a redislocation.

All the patients who had anatomical cures were, at the time of reduction, less than three and one-half years old. All the patients who, at the time of reduction, were over four years old showed a redislocation.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

The Filament-Nonfilament Count in Chronic Arthritis. An Aid in the Differentiation of Rheumatoid Arthritis and Osteo-Arthritis. Otto Steinbrocker and E. F. Hartung. *J. Am. Med. Assn.*, C, 654, 1933.

The authors state that in their studies of chronic rheumatic diseases they have resorted to various aids to facilitate the diagnosis and differentiation of chronic rheuma-

toid arthritis and osteo-arthritis; and in the filament-non-filament count, as recently advocated by Farley, McClaire, and Reisinger, they find a method which they believe offers some value in differentiating between these two conditions. The authors' study of a series of fifty patients with rheumatoid or chronic infectious arthritis reveals some interesting results, and they feel that the filament-non-filament count is helpful in differentiating between rheumatoid arthritis and osteo-arthritis when within normal limits. A normal count indicates that chronic rheumatoid infection is not present; an elevated count may indicate the presence of rheumatoid arthritis, rheumatoid and osteo-arthritis, or osteo-arthritis with active focal infection.—*Herbert E. Hipps, M.D., Marlin, Texas.*

Dupuytren's Contraction. Sumner L. Koch. *J. Am. Med. Assn.*, C, 878, 1933.

The author calls attention to the original article by Dupuytren in 1932, in which he very adequately and thoroughly describes the symptomatology, physical findings, and pathology of this condition. The line of treatment which he advised is to this day the one and only treatment which will entirely, completely, and permanently cure this condition. A review is made of the various phases concerning the etiology of the disease and the author notes that it is a significant fact that a family history may be elicited from almost all patients having this condition.

In considering the treatment of Dupuytren's contraction, he lays constant stress on certain factors,—the correct choice of incision, the use of a tourniquet, complete removal of the hopelessly involved skin, and removal of the palmar fascia well beyond the obviously involved area. Exacting care should be used in the dissection to protect the nerves and blood vessels, and a free full-thickness graft should be employed if skin edges cannot be brought together without undue tension. The incision formerly used ran longitudinally in line with the cord; now, however, a transverse incision is used, with the edge curled down. These incisions heal more rapidly, more readily, and with a minimum of scar-tissue formation, since they do not cross the normal flexion creases of the palm and they permit wider exploration of the involved fascia. Another factor of importance is the protection of the digital nerve. The digital nerves lie between the two layers of the digital fascia. These two layers fuse and become converted into the thick, fibrous cord and the nerve becomes completely surrounded by firm, fibrous tissue. If the cord contracts, the nerve is not uncommonly displaced to one side or the other as much as one and one-half centimeters. The nerve must be followed with extreme care and dissected free from the fibrous tissue that surrounds it before any of the fibrous tissue is excised.—*Herbert E. Hipps, M.D., Marlin, Texas.*

Chondromalacia of the Patella. Fissural Cartilage Degeneration; Traumatic Chondropathy: Report of Three Cases. Jacob Kulowski. *J. Am. Med. Assn.*, C, 1837, 1933.

Chondromalacia of the patella is a definite clinical entity and usually occurs in the young. The history is one of chronic disability, with general symptoms of internal derangement of the knee; pain is usually referable to the patella; and, occasionally, there is an intermittent serous effusion of the knee joint. Examination shows localized patellar pressure when the knee joint is in acute flexion and subpatellar crepitus is elicited on palpation. X-rays yield little of definite value, but occasionally show slight hypertrophic changes at either tip of the patella or in the joint. In milder cases, physiotherapy, limited activity, and bracing are indicated. In more severe cases, arthroplasty of the subpatellar surface gives the best results.

The etiology of this condition is somewhat obscure, and, in all probability, is closely associated with the supposed etiology of hypertrophic arthritis. Trauma must be assigned as a primary force, superimposed on a background of constitutional predisposition, plus the poor regenerative capacity of the cartilage and patella. The central

portion of the patella is most poorly supplied with blood and it is here that the first changes appear. Microscopic examination of the areas removed proves definitely that the degenerative area on the cartilage is a true pathological stage since there is a fibroid impregnation of the vessel walls and definite microscopic evidence of degenerative changes.

The author reports three cases, the first to appear in our literature, although this condition has been discussed frequently in foreign medical journals. In each case generalized internal knee symptoms were present. An operation was performed in each case and ulceration and cartilaginous degeneration on the under surface of the patella were found. Excellent results followed each operation.—*Herbert E. Hipps, M.D., Marlin, Texas.*

METABOLIC AND THERAPEUTIC STUDIES IN THE MYOPATHIES WITH SPECIAL REFERENCE TO GLYCINE ADMINISTRATION. Meyer M. Harris and Erwin Brand. *J. Am. Med. Assn.*, CI, 1047, 1933.

Since Aran, in 1850, published a paper on myopathies, much study has been given to the subject both clinically and physiologically. One outstanding fact is that in these conditions the output of creatinine is less and that of creatine more. In normal function, the reverse is true. The effect of feeding glycine to dystrophy cases is an increase in creatine excretion. These cases showed a markedly diminished tolerance for creatine.

A careful report, including charts, is given of numerous experiments with feeding of glycine and other similar products. Clinically the results seem variable. Some appear to have improved while others have remained the same. It is very difficult to estimate improvement in these cases.—*P. M. Girard, M.D., Dallas, Texas.*

TUBERCULOSIS OF THE GREATER TROCHANTER. Henry W. Meyerding and Rudolph J. Mroz. *J. Am. Med. Assn.*, CI, 1308, 1933.

A review of the literature is given, in which are mentioned some thirty-five cases of tuberculosis of the bursa in this region and eleven cases involving the trochanter. Most of the literature on this subject relates to case reports.

The authors report a series of nineteen cases. The patients were adults whose average age was thirty-five years.

The treatment advocated is complete excision of the bursal sac and thorough excision or curettement of the bone cavity. No drains are placed unless a large space is left, in which case a small rubber-tissue drain is used for serum drainage. A pressure bandage over the area is advised.

The postoperative treatment should include general up-building of the patient,—proper diet, cod-liver oil, and heliotherapy, both local and general.—*P. M. Girard, M.D., Dallas, Texas.*

THE IMMEDIATE TREATMENT OF COMPOUND FRACTURES. THE ALBEE BONE GRAFT AND THE WINNETT ORR METHOD OF POSTOPERATIVE CARE. H. Winnett Orr. *J. Am. Med. Assn.*, CI, 1378, 1933.

For many years the author has packed wide open all compound fractures, using vaselin-gauze packs. Recently a severe compound fracture of the tibia, with a loss of two and one-half inches of the shaft, was treated. After placing a pin through the os calcis and upper end of the tibia, an Albee bone graft was done, the wound being packed wide open, using vaselin gauze. The entire leg was placed in a plaster cast, in which the pins were incorporated. The graft lived, but was slow to unite at the lower end where it had been driven into the medullary canal.

The author feels that the above method saved the patient considerable convalescing time.—*W. B. Carrell, M.D., Dallas, Texas.*

Subperiosteal Resection of the Tibial Shaft in Osteomyelitis. D. M. Bosworth. *J. Am. Med. Assn.*, CI, 1542, 1933.

The author reviews the literature on the subject and finds that of six reports only four end results are given. He warns against resection of the tibial shaft whenever it can be avoided. It should be done only after conservative treatment, well carried out, has failed, leaving the patient profoundly toxic and overcome by infection, or with definite signs of advancing amyloid degeneration.—*W. B. Carrell, M.D., Dallas, Texas.*

Original Features of Arthroplasty of the Hip and Knee. Fred H. Albee. *J. Am. Med. Assn.*, CI, 1694, 1933.

A brief résumé of the history of arthroplasty is given. Emphasis is placed upon the proper angle for muscle pull upon the trochanter in order to have good function. Formerly, the author did not operate upon ankylosed hips in which there was considerable shortening of the neck, because he felt that the leverage effect of muscle pull upon the trochanter was inadequate. However, the head of the femur is now made much smaller than the acetabulum and is prevented from dislocating by partial osteotomy of the trochanter, levering it outward and placing new bone in the intervening space in order to hold it out. This added leverage upon the upper end of the femur prevents dislocation and favors general good function. Complete operative technique is described, also postoperative care.

Indications and contra-indications for arthroplasty of the knee are given. Generally a specific indication for the operation is two stiff knees or a stiff knee and a stiff hip on the same side.

The fascia-lata strip for both hip and knee arthroplasty should have left upon it approximately half of the subcutaneous fat. This fat flows into the dead spaces of the joint after closure and prevents the formation of hematomata. Following arthroplasty, the application of a cast and traction are very important as they prevent muscle spasm from crushing and devitalizing the fascial graft.—*W. B. Carrell, M.D., Dallas, Texas.*

Knee Joint Arthroplasty. W. Russell MacAusland. *J. Am. Med. Assn.*, CI, 1699, 1933.

This is a report on some interesting aspects of arthroplasty of the knee observed by the author over a period of years.

Complicating infection from latent foci has been observed not infrequently. Four case reports are given, indicating this source as against operative infection.

The operative technique is described with emphasis upon careful remodeling of the joint, in order to insure stability and to prevent arthritic changes in later life. The after-care is given and, in conclusion, the author reports five cases of patients ranging from six to twenty-three years of age who have had excellent knee arthroplasties.—*P. M. Girard, M.D., Dallas, Texas.*

Idiopathic Scoliosis. Stuart H. Scougall. *Med. J. Australia*, II, 271, 1933.

While some thirty causes of scoliosis are listed, Steindler finds forty-eight per cent. of 700 cases falling in the group of "idiopathic scoliosis", in which the cause is unknown. The age of onset is usually between seven and ten years. The usual types are the total left and the combined right dorsal curves. Evidently these spines possess less than the normal resistance to weight-bearing. Present opinion is that habitual posture of school life cannot be considered responsible.

As to treatment, prophylaxis should be concerned with nutrition and with recognition and treatment of prescoliotic attitudes.

The attainment of a compensatory curve, rather than maximum correction of the curve, is easier, is attained in a shorter time, and is less difficult of retention than maximum correction, and is probably the best choice for the average case.

The objectives of treatment include: (1) mobilization to the point of securing compensation, and not beyond a correction which can be voluntarily retained; (2) redressement to obtain compensation where mobilization alone fails; (3) retention. In the author's opinion retention should be secured voluntarily in most cases; by a support, in a fair proportion of cases; and, in a few, by fusion, but not until the child has attained his growth.—*Edward N. Reed, M.D., Santa Monica, California.*

Die Verwetung des Tubergelenkswinkels in der Beurteilung von Verletzungen und Erkrankungen des Fersenbeines (The Value of the Tuber-Joint Angle in the Diagnosis of Injuries and Lesions of the Os Calcis). W. Ehalt. *Monatschr. f. Unfallheilk.*, XL, 25, 1933.

The tuber-joint angle of Böhler is formed by following two lines: a line from the highest point of the anterior joint surface to that of the posterior joint, and a line from the highest point of the posterior joint to the upper part of the tuber. Both lines form an angle of about thirty degrees in normal feet. A smaller value is suggestive of a fracture of the os calcis. For the diagnosis of a fracture of the os calcis, an axial view is also indispensable. The foot is brought into dorsal flexion, the plate lies below the heel and the picture is taken at an angle of about forty-five degrees. In a positive case, shortening and thickening of the os calcis can be seen. A case is reported of a man twenty-one years old, who, after a jump, had marked pain in the heel and was unable to walk. He was seen in the hospital six months after the onset. Roentgenograms showed a normal axial view; in the lateral view the tuber-joint angle was zero, and there was a subluxation in Chopart's joint. If the decrease of the angle were due to a fracture, the axial picture would show shortening and thickening of the bone. Therefore, fracture was excluded and the diagnosis of a destructive process of the posterior portion of the subastragaloid joint was made, probably tuberculosis.—*Ernst Freund, M.D., Iowa City, Iowa.*

Beck's Disease and Achondroplasia. G. I. Turner. *Novii Khirurgicheskii Arkhiv*, CVII, 350, 1932.

Under the name of Beck's disease, the author describes a peculiar form of endemic osteochondritis observed in the valley of the river Urov in eastern Siberia. It was first reported in 1903, and then scientifically described by a military surgeon, Dr. E. Beck, in a masterly monograph in 1906.

The disease usually affects males between the ages of eight and twenty years. The onset is insidious. The phalangeal joints swell and enlarge, and the larger joints then become involved in various combinations. The muscles become atrophied, contractures set in, and ankyloses and compensatory spine deformities follow. The entire skeleton becomes involved, and there is at times a marked delay in the growth of the long bones, especially the humeri.

There is a marked disproportion between the upper and lower parts of the body. The x-ray picture is that of a profound deforming process of the larger joints, accompanied by osteoporosis of the epiphyses, sometimes by early ossification of the epiphyseal plates. This picture is very frequently associated with an enlarged thyroid gland.

The author finds a most marked resemblance of this condition to achondroplasia, and thinks that the disease belongs to the indefinite group of chondrodystrophy, osteogenesis imperfecta, etc.

The pathogenesis of Beck's disease is obscure. The author suspects a possible toxic element responsible for this affliction and suggests a thorough study of the local conditions. The population of this area lives in unheard-of unhygienic surroundings. There is a possible organic or mineral element in the water of the river Urov which may throw a new light on the etiology of Beck's disease and, secondarily, on the correlation of thyroid enlargement and osteo-arthritis.—*Emanuel Kaplan, M.D., New York, N. Y.*

POST-TYPHOID SPONDYLO-ARTHRITIS. A. Osiński. *Polski Przeglad Radjologiczny,* VII, 291, 1932.

Three cases of post-typhoid spondylo-arthritis of the lumbar spine are described by the author. The x-ray picture is characteristic and consists of a destruction of the intervertebral disc, an erosion of the superficial layers of the vertebral body, and signs of active reparation.

In all three cases, in addition to the typhoid history, there was a coincidental history of light trauma.

There was a favorable development of the lesion in all the cases, and this is considered an important element in differentiating this affliction from tuberculosis of the spine.—*Emanuel Kaplan, M.D., New York, N. Y.*

RADICULITIS. M. J. Hubeny. *Radiology,* XX, 331, 1933.

Radiculitis is an inflammation of the spinal nerve roots whose manifestations, sensory and motor, show by their distribution that the lesion is not in the tracts or nuclei of the cord, or in a peripheral nerve trunk, but in the spinal root. While syphilis and tuberculosis are frequent causes, radiculitis may result from spinal osteo-arthritis, causing pressure in the narrowed canals. The dura, which surrounds the nerve roots, is separated from the wall of the intervertebral canal by a very small interval containing plexiform veins and loose fatty tissue. The fifth lumbar roots almost completely fill the canal, while the openings become progressively larger, in relation to the size of the roots, from below upward.

Spondylitis deformans is an inflammatory process with pararadicular exudation, followed by fibrosis and encroachment upon the lumen of the intervertebral canal. Infection is probably the determining cause, and trauma a frequent predisposing factor.

The hypertrophic process may be extensive without roentgenographic evidence of its presence; and, conversely, many hypertrophic roentgenographic findings exist without any symptoms. In the diagnosis, cord lesions and visceral disease with reflex symptoms must be ruled out.

The outstanding symptoms are: pain, aching, soreness, and stiffness.

The basis of the paper is a case under observation for fourteen years, with osteo-arthritic involvement of multiple joints and radicular pains from involvement of vertebral bodies, simulating the pains of duodenal ulcer, gall-bladder disease, pylorospasm, spasm of the colon, disease of the prostate and rectum, and backache.—*Edward N. Reed, M.D., Santa Monica, California.*

EXPERIENCE IN IRRADIATING ALL TYPES OF BONE TUMORS. Max Kahn. *Radiology,* XX, 428, 1933.

In regard to radiability, bone tumors are divided into benign and malignant, and subdivided into radiosensitive, partly sensitive, and non-radiosensitive.

Of the benign tumors, the giant-cell tumors, both the typical and the variant type—a bone cyst containing giant cells—are radiosensitive; a number of the latter have been cured by radiation alone.

Typical bone cysts and exostoses are benign, but not radiosensitive. Chondromata, benign growths, are partly radiosensitive. Radiation slows their rate of growth.

Of the malignant tumors, Ewing's tumor and chondroblastic sarcomata are slowed down by irradiation, but finally metastasize. Secondary chondromyxosarcomata are partly radiosensitive, as are metastatic carcinomata, and irradiation affords marked symptomatic relief and slowing of the process, and should always be done. Metastases from hypernephromata do not yield well to radiation.

Sarcomata of bone are not benefited by irradiation.

As to treatment of malignant bone tumors, surgical removal, if possible, should be done, followed by irradiation. If removal is impossible, irradiation should be thoroughly carried out. Bone tumors, whose nature has not been definitely ascertained, should be radiated at once and until a definite diagnosis has been made. It is essential that the

irradiation be done by one thoroughly experienced.—*Edward N. Reed, M.D., Santa Monica, California.*

RESULTS OF IRRADIATION IN THE TREATMENT OF OPERABLE OSTEOGENIC SARCOMA OF THE LONG BONES. William B. Coley. *Radiology*, XXI, 318, Oct. 1933.

The results from surgical treatment of osteogenic sarcoma have been poor. The efficiency of preoperative and postoperative irradiation has been so questionable that surgeons are divided as to its advisability. Twenty years ago the percentage of five-year recoveries following amputation was from two per cent. to four per cent. In recent years, earlier diagnosis and earlier surgery have considerably improved these figures. Because of the small success of amputation in the past, the present trend is to treat these tumors by irradiation alone.

A recent analysis of the results of irradiation in a considerable number of cases leads to the conclusion that this type of tumor is too resistant to irradiation to justify its employment.

The author believes that the best method of treatment is immediate amputation followed by a prolonged course of treatment with Coley's toxins. He does not commend the practice of giving a month of irradiation, while submitting the roentgenograms to a number of authorities for confirmation of the diagnosis. With few exceptions, a correct diagnosis should be made by any competent roentgenologist. To wait for an absolutely positive diagnosis is to wait too long. If real doubt of the diagnosis exists, biopsy should be done and paraffin sections waited for. This short delay is justifiable.

The article quotes a number of authorities, among them Bloodgood, who, in opposition to the author's opinion, advocate a thorough course of deep x-ray preliminary to amputation.

The author lists thirty-three cases of osteogenic sarcoma of long bones, in which the patients are well five years after treatment. In all but eight of these cases, Coley's toxins were used. Eleven cases of involvement of flat bones with a five-year cure are also enumerated, all of which were treated with toxins.

In contradistinction to the above, the endothelial myeloma type of bone sarcoma is highly sensitive, both to irradiation and to Coley's toxins, and should be treated with these for four to six weeks before resorting to amputation.

In cases of inoperable tumors, irradiation is of considerable value in the relief of pain, and in retarding tumor growth. Far-advanced, inoperable cases should be treated by morphine alone.—*Edward N. Reed, M.D., Santa Monica, California.*

GIANT-CELL BONE TUMOR. SOME CONSIDERATIONS OF TREATMENT. Carleton B. Peirce. *Radiology*, XXI, 348, Oct. 1933.

The author considers the giant cell of the bone tumor an osteoclast which is less mature and less differentiated, in other words more embryonal, than the normal osteoclast. This immaturity results in its tendency to grow wild, coalesce, and produce giant cells, and overstep the normal bounds of its functions, producing abnormal osteolysis. Furthermore, its immaturity makes it radiosensitive. Radiation hastens its maturation and senescence, curbing its abnormal activity. Such cells, after irradiation, tend to return to normal limits, whereupon the constructive bone elements are permitted to restore more or less normal structure to the involved bone.

Giant-cell bone tumors permit of diagnosis by roentgenographic study alone, with modern technique.

Surgical treatment alone has given less favorable results than roentgenographic treatment alone, or than surgery combined with radiation, and the author thinks that in most cases radiation alone is entirely adequate treatment and that surgery is unnecessary. If surgery is done, the treatment should include chemical or thermal cauterization and preoperative and postoperative irradiation.

Attention is called to the possibility of malignant degeneration in these tumors.—*Edward N. Reed, M.D., Santa Monica, California.*

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THE LUMBOSACRAL JUNCTION*

BY G. A. G. MITCHELL, M.B., CH.M., ABERDEEN, SCOTLAND
Lecturer in Anatomy, Aberdeen University

The diagnosis of the cause of low-back pain and disability has always been regarded as one of the most difficult problems the clinician has to tackle, and among the many factors which militate against success not the least important is the wide-spread ignorance of the anatomy of the lower back and the mechanics of the lower spine. Our anatomical text-books devote too little attention to this extremely important region, and they are particularly reticent about the lumbosacral and sacro-iliac articulations. The following description is an attempt to remedy this neglect in respect to the lumbosacral junction, and it is contributed in the hope that the presentation of old and new facts may help to explain many of the symptoms, signs, and sequelae of lumbosacral derangements. It is no exaggeration to say that a knowledge of the anatomy and mechanics of the junction is essential before the etiology and pathology of most lumbosacral lesions can be appreciated.

There are three articulations between the last lumbar vertebra and the sacrum, an amphiarthrodial joint between the corresponding vertebral bodies, and two diarthrodial joints between the articular processes of the vertebral arches. The bodies are united by a thick, powerful, wedge-shaped, intervertebral fibrocartilage, and by prolongations of the anterior and posterior common longitudinal ligaments of the spinal column. A number of ligaments connect the vertebral arches and their processes,—namely, ligamenta subflava between the laminae, and interspinous and supraspinous ligaments between the spinous processes, while the articular processes on either side are connected by articular capsules and synovial membranes. The interspinous and supraspinous ligaments are rather indefinite structures, but the ligamenta subflava are strong and elastic, since they contain a considerable proportion of yellow elastic tissue. In place of the usual intertransverse ligaments, two special lateral lumbosacral ligaments are developed; each is somewhat fan-shaped and is attached

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above to the inferior border of the transverse process of the last lumbar vertebra, while below it spreads out to become attached to the ala of the sacrum close to the sacro-iliac articulation, where it blends with the anterior sacro-iliac ligament (Fig. 1). An inconstant band of fibers extends between the front of the sacral ala and the inferolateral aspect of the last lumbar vertebral body. According to Cunningham, this band lies in front of the anterior ramus of the fifth lumbar nerve. Another specialized ligamentous development is the iliolumbar ligament, which extends from the last lumbar transverse process to the inner lip of the iliac crest, where it is attached for about two inches immediately anterior to the iliac auricular surface (Fig. 1). Occasionally this ligament gains an additional weak attachment to the transverse process of the fourth lumbar vertebra, and it is really a specially thickened part of the lumbodorsal fascia. The lateral lumbosacral and iliolumbar ligaments are frequently described together as the lower and upper parts of the iliolumbar ligament.

In addition to these ligamentous ties, adjacent muscles perform the function of powerful elastic ligaments. Their distribution, however, is remarkably unequal, large masses—such as the erector spinae and psoas major—lying posteriorly and laterally, while the anterior aspect, which needs protection most, is uncovered and unprotected by muscles. Other muscles of less power and importance—such as the multifidus, quadratus lumborum, and rudimentary interspinous and intertransverse muscles—also assist in binding the bones together. By virtue of their postural tonus all these muscles are of great importance in maintaining stability at the lumbosacral junction in every position of the body, and their rôle of "ligament sparers" is second only in importance to their kinetic function. Even in the recumbent position their action is important, and there is little doubt that there is a predisposition to low-back strains, if the postural tonic activity of the muscles is diminished or interfered with in any way. The muscular relaxation produced by anaesthesia and the muscular weakness engendered by prolonged or debilitating illnesses both interfere with muscular tonus, and, as a consequence, any support which the muscles normally afford in maintaining lumbosacral stability is almost completely abolished. As a result, the entire onus of maintaining the normal anatomical relationships is thrown on the ligaments, which tend to stretch under the unaccustomed stress, and thereby lumbar or lumbosacral strain is produced.

Certain nerve relationships are very important and have a considerable bearing on the production of a number of the symptoms and signs in such lumbosacral derangements as strain, spondylolisthesis, etc. The lumbosacral cord, which is composed of a part of the anterior division of the fourth and the whole of the anterior division of the fifth lumbar nerves, pierces the medial margin of psoas major close to the anterolateral aspect of the lumbosacral junction and then passes downward over the sacro-iliac joint to enter the sacral plexus. The anterior primary division of the fifth lumbar nerve emerges through a canal bounded by the pedicle

of the last lumbar vertebra above, the sacral ala below, the last intervertebral disc antero-internally, and the psoas major, lateral lumbosacral, and ilio-lumbar ligaments postero-externally. In some instances the nerve is crossed anteriorly by a membranous band stretching between the front of the sacral ala and the body of the last lumbar vertebra. It is the largest of the anterior primary divisions of the lumbar nerves, yet the lumbosacral foramen through which it emerges is, in most cases (though not always, as has been stated), smaller than any of the lumbar intervertebral foramina. The posterior primary divisions of the fifth lumbar nerves turn backward and run close to the outer sides of the articulations between the lumbosacral articular processes, and then sink into the muscles of the back. The very close relationships of these nerve divisions to the various parts of the lumbosacral junction are worthy of note, because they may be affected by articular or periarticular swellings or exudations, or by arthritic changes. Each nerve as it emerges through the intervertebral canal is surrounded by a plexus of veins, and the theory has been formulated that congestion in these venous plexuses may cause pressure on the nerves and so produce pain. This is particularly liable to happen in the case of the fifth lumbar nerves, owing to their large size and the relatively small intervertebral foramina through which they pass. Moreover, Boniot and Forestier state that the fourth and fifth lumbar nerve roots are not protected by arachnoid sheaths and that they are, therefore, easily influenced and irritated by variations in the rich venous

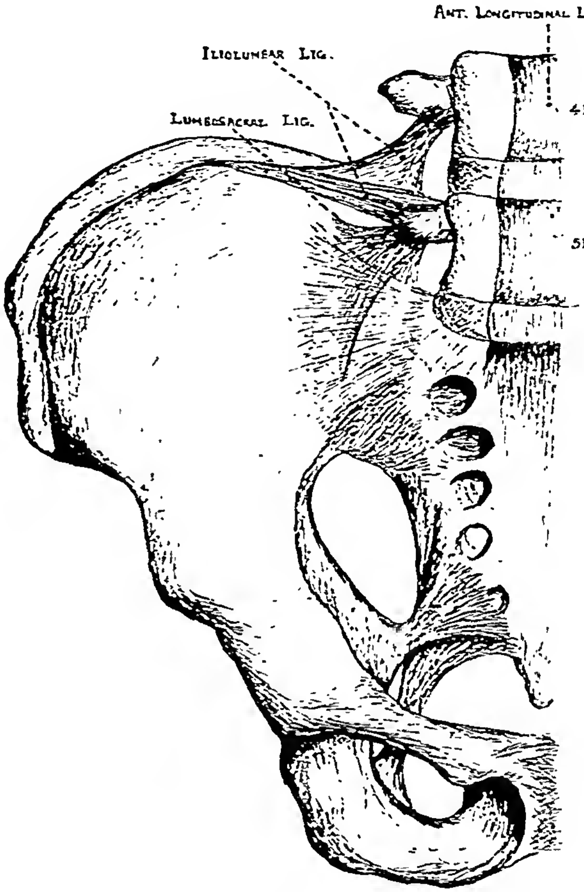

Fig. 1

The ligaments of the lumbosacral junction as seen from the front.

plexus contained in the bony canal; this appears to be an isolated observation which has not been confirmed.

The following additional relationships of the lumbosacral junction are of less practical importance. The middle sacral vessels, the presacral nerve or plexus, the parietal peritoneum, and coils of ileum lie anteriorly; the common iliac vessels and lymph glands, the sympathetic trunks, and the ureters lie anterolaterally; while the termination of the mesentery lies to the right and the descending colon to the left of the junction. The muscular relationships have been indicated already.

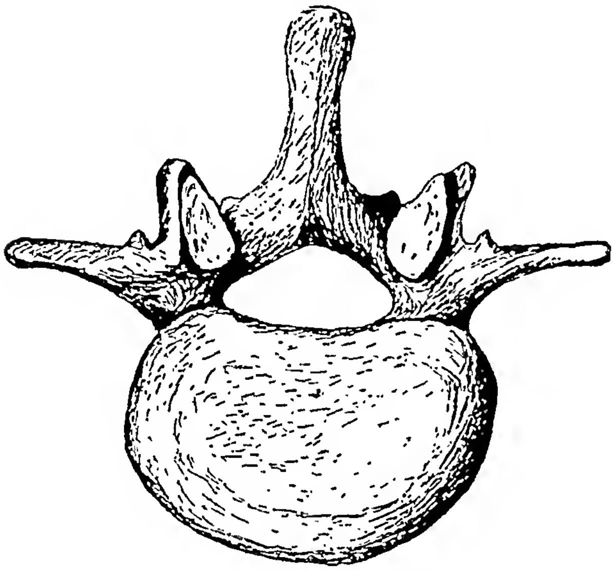

Fig. 2
A third lumbar vertebra (upper surface).

The component parts of the junction receive arterial twigs from the superior lateral sacral and iliolumbar arteries, and they are innervated by the fourth and fifth lumbar nerves.

In the spine with its multitude of joints, it is manifestly impossible to determine the exact degree of movement possessed by any individual joint, but the movement in each unit can be fairly accurately estimated by a consideration of the movements of the whole region to which it belongs. It is, therefore, possible to obtain some idea of the amount of lumbosacral mobility by studying the movements of the lumbar region as a whole. The range of mobility in the lumbar region varies within wide limits, being influenced by the shape and disposition of the vertebrae and their articular processes, the resiliency of the connecting structures, the anatomical configuration of the individual, and, under certain circumstances, by the presence of anomalous developments or pathological processes.

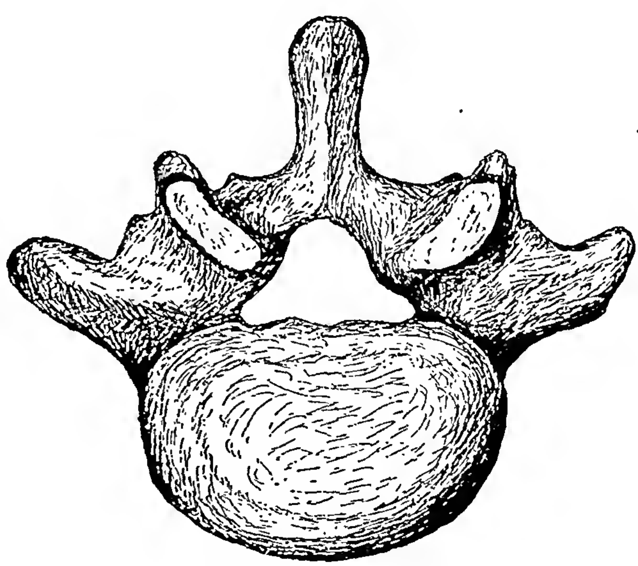

Fig. 3
A fifth lumbar vertebra (upper surface).

Goldthwait has emphasized how spinal mobility is dependent on the anatomical type of the individual, and he has distinguished two clearly contrasted types: (1) the visceroptotic type, with poor muscular development, a long narrow back, and a flexible spine, often showing lumbar lordosis and a sharp sacrovertebral angle; and (2), the exact opposite of Type 1,—a heavy individual, with a short, thick-set body, limited mobility

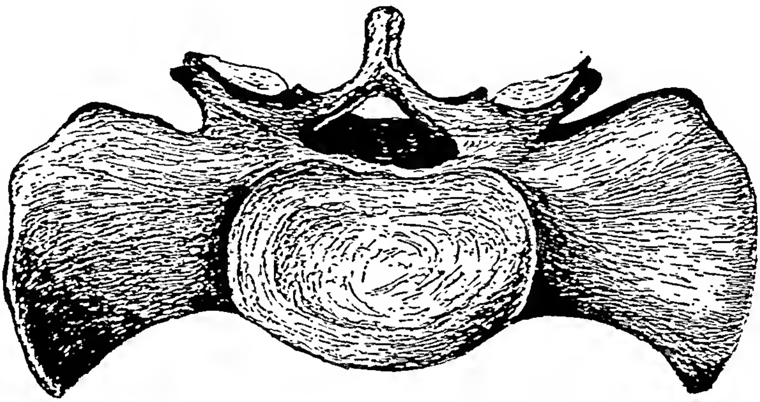

FIG. 4

The superior surface of the sacrum. This diagram, along with the two preceding figures, shows the gradual alteration in the direction of the articular processes.

of the lumbar spine (lateral bending in particular being limited), and a varying degree of lumbar lordosis. In the second type the vertebral bodies and articular processes are large, the latter having crescentic facets, whereas in the first type the vertebral bodies and articular processes are smaller and the articular facets are flattened. The lumbosacral articular processes share in these changes, and these differences in the bones and soft parts explain the variations in the spinal mobility in the two types. The alterations in lumbosacral mobility due to abnormalities and disease cannot be discussed here, but some reference will be made later to the effects of anomalous developments on the stability of the parts.

The lumbar portion of the spine is comparatively movable, flexion, extension, and lateral bending being permitted between the opposing vertebral bodies, while gliding movements occur between the articular processes. All the above movements can take place at the lumbosacral junction, and, in addition, slight rotatory movements are possible. Rotation is usually impossible between the lumbar vertebrae, so it is worth while considering why it is possible at the lumbosacral junction. The lower articular processes of the last lumbar vertebra are powerful and set widely apart, and their articular facets are moderately convex and directed forward and slightly outward. The upper sacral articular processes are also powerful, embrace the lower lumbar articular processes, and are attached to the body of the first sacral vertebra and to the sacral alae by short, strong pedicles; their articular facets are moderately concave

and face backward and slightly inward (Fig. 4). This arrangement of the lumbosacral articular processes approximates closely the thoracic arrangement, and explains why rotation at the lumbosacral junction is a possibility. The adjacent facets on the other lumbar articular processes face more distinctly inward and outward, an arrangement which practically prevents rotation (Figs. 2 and 3). Many observers have pointed out that the lumbosacral articular processes are frequently asymmetrical, and that this results in uneven rotation and in unequal stresses being borne by the two sides during movements. Many, too, have stated that the added movement of rotation is a source of weakness, as flexibility and strength are opposing virtues, but in the case of the lumbosacral junction this is only partly true. These observers have failed to realize that the joint would be weaker still if the articular processes were arranged like those of the other lumbar vertebrae so that no rotation could occur.

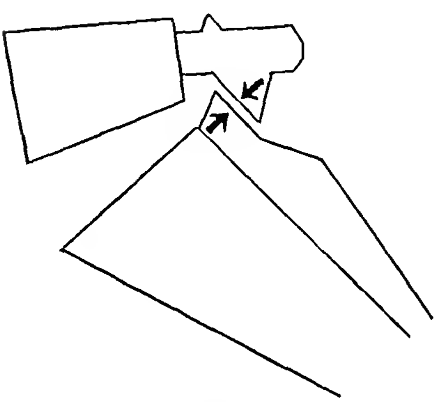

Fig. 5
A diagram to indicate the buttress-like (antiluxation) action of the lumbosacral articular processes.

Owing to the tilt of the upper surface of the first sacral vertebra, the last lumbar vertebra is constantly tending to slide downward and forward when the trunk is erect, a contingency which is prevented by the lumbosacral intervertebral disc, ligaments, and muscles, and by the arrangement of the lumbosacral articular processes which, being arranged practically in a coronal plane, impinge upon each other when the last lumbar vertebra tends to slip downward and forward on the sacrum and thus act as buttresses, preventing forward displacement (Fig. 5). Certainly this arrangement allows rotation, but it also prevents forward dislocation, and, therefore, though the added mobility is a source of weakness, it is in this instance the lesser of two evils, for the loss of strength in one direction is more than compensated for by a gain in another.

From the mechanical view-point there are no more important or interesting articulations in the body than the lumbosacral. They have to bear the whole superincumbent body weight, plus any weight lifted by the arms or supported on the head and shoulders, and, as these additional weights are at the opposite ends of the spinal lever, the stresses they produce are greatly magnified. As a consequence, the lumbosacral junction has to withstand flexion, extension, and torsion strains under immense leverage, but, despite the magnitude of the forces it has to bear, it seems ill adapted in many ways for the support of heavy strains. The lumbar intervertebral joints are much sounder mechanical propositions, and some maintain that there are evidences that nature is attempting to improve matters by incorporating the last lumbar vertebra in the sacrum, thus obliterating the potentially weak lumbosacral junction and substituting a

more stable lumbar intervertebral joint. All observers are not agreed about this, and many maintain that variations at the lumbosacral junction are tending toward elongation rather than shortening of the lumbar part of the spinal column. Moreover, even when sacralization of the fifth lumbar vertebra has occurred, the resulting sacrovertebral junction resembles a normal lumbosacral junction rather than a normal lumbar intervertebral joint. Be that as it may, the frequency of lumbosacral variations is a good index of the instability of the region and its tendency to evolutionary change.

No one doubts that man's ancestors were quadrupeds at some stage of their existence, but a great deal of controversy has arisen regarding the exact stages by which a quadruped with its pronograde gait has scaled the heights and developed into a biped with orthograde gait. For the purposes of this discussion it matters not whether we agree with Keith that the evolution of man's erect posture has developed through hylobatian-troglodytian phases, or believe with Wood Jones that it is entirely independent of the habit of brachiating for its inception. The vital fact remains that the prevailing direction of the spinal axis in our primitive ancestors was horizontal, while in *homo sapiens* the spinal axis is almost vertical, and it is obvious that marked skeletal changes must have occurred in order to make the change possible. These changes have affected practically every part, but are specially evident about the sacrovertebral junction, where changes have occurred, and are still occurring, to enable the erect posture to be maintained comfortably. It is highly important to realize, however, that these are makeshift arrangements, and undoubtedly therein lies the explanation of a good deal of the backache which human flesh is heir to. The enterprise of our forefathers is being visited on the children far beyond the third and fourth generations! Modifications of a structure primarily designed for the quadruped posture cannot be absolutely satisfactory for an erect posture which distributes the body weight very unequally along the axial skeleton and between the different limb girdles.

We have the evidence of fossil remains to testify that the lumbosacral junction of our prehistoric ancestors was mechanically more perfect than our own. One might quote here the evidence supplied by Marcellin Boule from a study of the very complete skeletal remains of Neanderthal men found at La Chapelle-aux-Saints and La Ferrassie. Many fanciful reconstructions of prehistoric men have been made, but most are built up on such a flimsy basis that they are not worthy of serious attention. To reconstruct a complete man from a fragment of a skull or a lower jaw is doubtless highly ingenious, and manifestly highly satisfactory to his recreator, but scarcely likely to be scientifically accurate. The skeletons from La Chapelle-aux-Saints and La Ferrassie were sufficiently complete to reduce speculative reconstruction to a minimum, and from his reconstructions Boule proved beyond reasonable doubt that the slight curve of the cervical and lumbar regions must have given Neanderthal man a

crouching posture (a position which is habitual in fossil men and savage peoples), and an ordinary carriage which must have differed in some degree from our own. The crouching posture is an ancestral survival, and it requires little imagination to picture it as a step on the road from the quadruped to the upright position. In prehistoric men the trunk was longer and less heavily built, the sacrum and pelvis were narrower, and the sacrum was set very deeply between the iliac bones. Owing to the crouching posture and the comparative straightness of the lumbar curve, the sacrum was placed more on a plane with the rest of the spinal column so that there was comparatively little sacrovertebral angulation. This is a more stable arrangement than that found in modern European skeletons in which this state of affairs is only found in the very young. In a two-months' foetus the spine and sacrum form a straight line and the sacrum shows no curvature. Later the sacral curvature appears and gradually becomes more marked, while an angle begins to develop at the lumbosacral junction. At birth there is only slight lumbosacral angulation, and the lumbar spine is almost straight; it is only when the child is learning to stand and walk that the forward convexity of the lumbar region develops. Could one wish for better proofs of Boule's assertion that "fossil man exhibits a morphology, the most striking and surprising traits of which are found in either the newly born or unborn infants of Europeans"?

Coming to more modern times, we find equally conclusive evidence that man's erect attitude is an evolutionary process, not yet perfect in any, but more perfect in some races than in others. About sixty years ago, while a member of the "Challenger" expedition, Prof. Turner examined the skeletons of the lowest and most primitive forms of the human race,—such as those of aborigines, Andaman Islanders, and other primitive peoples. Among other findings he made the interesting discovery that the lumbar region in these primitive races is almost straight or slightly convex backward; this corresponds closely with the prehistoric-man type of spinal column, and is one indication of the very primitive nature of these races. Prof. Low has found that in certain "short-cist" skeletons belonging to the Bronze Age ("Beaker" men), the posterior vertebral measurements in the lumbar region slightly exceed the anterior, and it appears from reconstructions that there was only comparatively slight lumbosacral angulation. It is therefore evident that the lower spines of Neanderthal men, Beaker men, and the most primitive races of the present day have much in common. They differ from modern European skeletons in that the degree of lumbosacral angulation is considerably less, and the lumbar portion of the spinal column almost straight or even convex backward. The minor degree of lumbosacral angulation is an undoubted advantage from a mechanical point of view, and it is unlikely that our primitive ancestors suffered from any such condition as lumbosacral strain.

The bodies of the last lumbar and first sacral vertebrae and the lumbosacral intervertebral disc are all wedge-shaped, with the base forward. That is why there is a sacrovertebral angle, though when looked at from

the side it is often more of a curve than a definite angle. From personal observations and from measurements made by Aeby and Ravenel, it is clear that neither the lumbar vertebral bodies nor the intervening discs are wedge-shaped at birth, and that in all regions of the spine, except the sacral, the anterior and posterior vertical diameters are almost equal, so that the spine is practically straight. By the end of the second year definite wedging can be detected in the lumbar region and this gradually increases till adult age is attained. The process is most marked in the case of the last lumbar vertebra, and in fifty-eight such vertebrae from adults, examined by the writer, the average difference between the anterior and posterior vertical measurements amounted to five and two-tenths millimeters.

Fig. 6
Prespondylolisthesis.

The development of the sacrovertebral angle and the lumbar forward convexity are designed to allow the trunk to be held erect, despite the position of the sacrum. During the change from pronograde to orthograde the sacrum underwent a relatively small degree of axial displacement, compared with the rest of the spinal column, and thus it is not placed vertically between the iliac bones but is set at a distinct tilt. The magnitude of the sacrovertebral angle is variable, and is largely dependent on the degree of inclination to the horizontal of the upper surface of the first sacral vertebral body, which is dependent on the degree of sacral obliquity; this in turn is partly dependent on the pelvic inclination which is, on an average, a little greater in males than in females. The greater the inclination of the upper surface of the first sacral vertebral body, the smaller does the sacrovertebral angle become, and vice versa. This interrelationship, let it

be repeated, is mainly designed to maintain the erect position of the trunk, despite variations in the sacral obliquity; but the erect posture is sometimes maintained at the expense of stability, for any increase in the sacrovertebral angulation, necessary to overcome the effects of marked sacral tilting, accentuates the weakness already present, due to the markedly sloping platform on which the last lumbar vertebra has to rest. Up to a certain point the sacrovertebral angle gradually becomes more pronounced as the individual grows older, due to the constant pressure of the weight of the trunk. Occasionally the sacrum comes to be placed almost horizontally in the body, and then the angle is usually very pronounced, even approaching a right angle, while a compensatory lumbar lordosis develops. This condition was recognized and recorded by Whitman as "prespondylolisthesis" (Fig. 6). Normally at the lumbosacral junction the bulk of the superincumbent weight is transmitted through the vertebral bodies and discs, and only a small proportion is transmitted through the articular processes, but any increase in the sacrovertebral angulation leads to more unequal distribution of the weight and the transmission of a greater proportion through the articular processes, with the result that the junction becomes less efficient mechanically.

A number of figures may be quoted relevant to these statements. The upper surface of the first sacral vertebral body is directed forward and upward, forming a varying angle with the horizontal, and providing a sloping platform for the last lumbar vertebra; the slope is decreased to some extent by the wedge form of the intervening disc. In twenty-eight European specimens the writer found that the average angle of inclination to the horizontal of the upper surface of the first sacral vertebral body was 41 degrees, and the average inclination of the upper surface of the last lumbar vertebra in the same specimens was 19 degrees. These figures give a good idea of the relatively flat and secure basis on which the fourth lumbar vertebra rests, as compared with the fifth. All the well known anatomical text-books give the average inclination of the upper surface of the first sacral vertebra as 42.5 degrees, and any figures within 5 or 6 degrees above or below this are within the limits of normality, fixation of which must be arbitrary. In two specimens not included in the twenty-eight used for the average, the inclination of the upper surface of the first sacral vertebra was abnormally large or small,—namely, 68 degrees in one (Fig. 7) and 32 degrees in the other. Von Lackum, in a series of specimens he examined, found that the extremes were 80 degrees and 28 degrees.

There is no disagreement about the above figures, but in regard to the so called sacrovertebral angle reliable information is unobtainable. Judging from the figures supplied, no two workers are agreed as to what the angle really is, or how it should be measured. Gray's, Quain's, Buchanan's, Cunningham's, Morris's, and Piersol's anatomical text-books supply general statements about it, but all fail to define it exactly, and none supply information as to how it should be measured. Neither Martin nor Duckworth give measurements of this very important angle,

though they are prodigal in their supply of figures of less importance. Morris and Buchanan alone, among the writers mentioned, give actual figures. Both state that the angle measures 117 degrees in the male and 130 degrees in the female. Frazer gives 120 degrees as the average size, but does not indicate by what method this figure was obtained. Von Lackum gives the average size as 109.7 degrees (117 degrees in the male and 102.4 degrees in the female), while Robinson and Grimm say the

FIG. 7

Prespondylolisthesis. Note the almost horizontal sacrum and the exaggerated tilt of the superior surface of the first sacral vertebra.

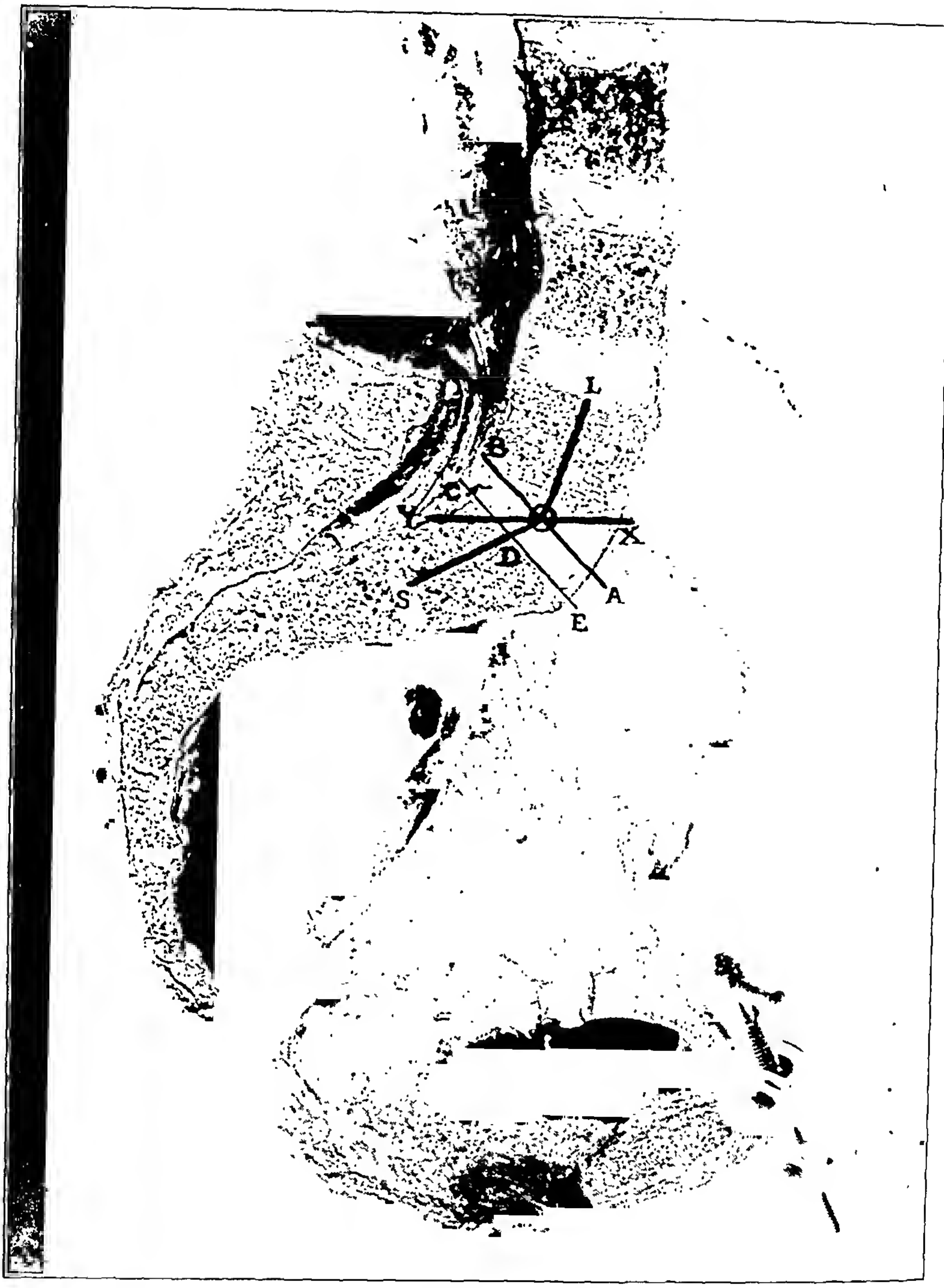

Fig. 8
For explanation of this diagram see text.

greater number measure from 148 to 155 degrees. No margin of experimental error will explain the discrepancies which exist between such figures as 109, 120, and 155 degrees, nor will racial differences explain such marked variation. The only feasible explanation is that the methods of measuring must have been different; this is proved by a study of the methods described by von Lackum and by Robinson and Grimm, which are as radically different in their execution as in their results. Von Lackum determined the sacrovertebral angle "by using a vertical upright

which approximated the line of spinal weight-bearing along the upper portion of the spinal column, and a line drawn through the approximate center of the first two sacral bodies for the lower side of the angle". The method employed by Robinson and Grimm is entirely different. By their method the angle between the last lumbar and first sacral vertebrae is measured, and the figures obtained are not comparable with those supplied by von Lackum. The lower part of the vertebral column is sectioned vertically in the median sagittal plane, the cut surfaces of the last lumbar and first sacral vertebral bodies are bisected from above downward, and the angle formed between these two lines when projected is the measurement taken. Using this method, they found that the most frequent angular relationship between the fifth lumbar and first sacral vertebrae approximated 155 degrees, while the extreme ranges were 128 degrees and 160 degrees. Using the same method, the author found that the average angulation was equal to 138.5 degrees (137 degrees in females and 140 degrees in males). This method has the great merit of being exact, and is capable of uniform application, but the measurement of the angle between the fifth lumbar and first sacral vertebrae cannot possibly correspond to the sacrovertebral angle of older writers. To distinguish them, the angle obtained by the method of Robinson and Grimm would be more correctly termed the *lumbosacral angle.*

The statement was made that the lumbosacral angle and the degree of obliquity of the upper surface of the first sacral vertebra were interrelated, and actual figures may be given to show how a change in the one is reflected by a change in the other. Here are two typical examples:

	I.	*II.*
Lumbosacral angle	135 degrees	141 degrees
Tilt of upper surface of first sacral vertebra	45 degrees	36 degrees

The relationship is not so easily explained as might appear at first sight, but a study of the accompanying diagram (Fig. 8) may be of some help in this respect. *LO* and *SO* are lines bisecting the last lumbar and first sacral vertebrae, the line *AOB* is parallel to the plane of the upper surface of the first sacral vertebra, and *XY* is a horizontal line. The angle *LOS* is the lumbosacral angle, and the angle *YOB* measures the inclination to the horizontal of the upper surface of the first sacral vertebra. The problem is to find how angles *LOS* and *YOB* are related. *AB* and *CE* are two parallel lines intersected by a third line *OS;* therefore, the angle *BOS* equals the angle *CDS*, and the latter angle is apparently remarkably constant in all adult sacra. On an average it measures 72 degrees, and seldom varies more than 5 degrees above or below this measurement. However, as the above average is based on measurements of specimens from only twenty-eight adult British subjects, no dogmatic statement can be made on this point. The lumbosacral angle *LOS* is the sum of angles *LOB* and *BOS*, but angle *BOS*, being equal to angle *CDS*, is for all practical purposes a constant, so any variations in the size of the lumbosacral

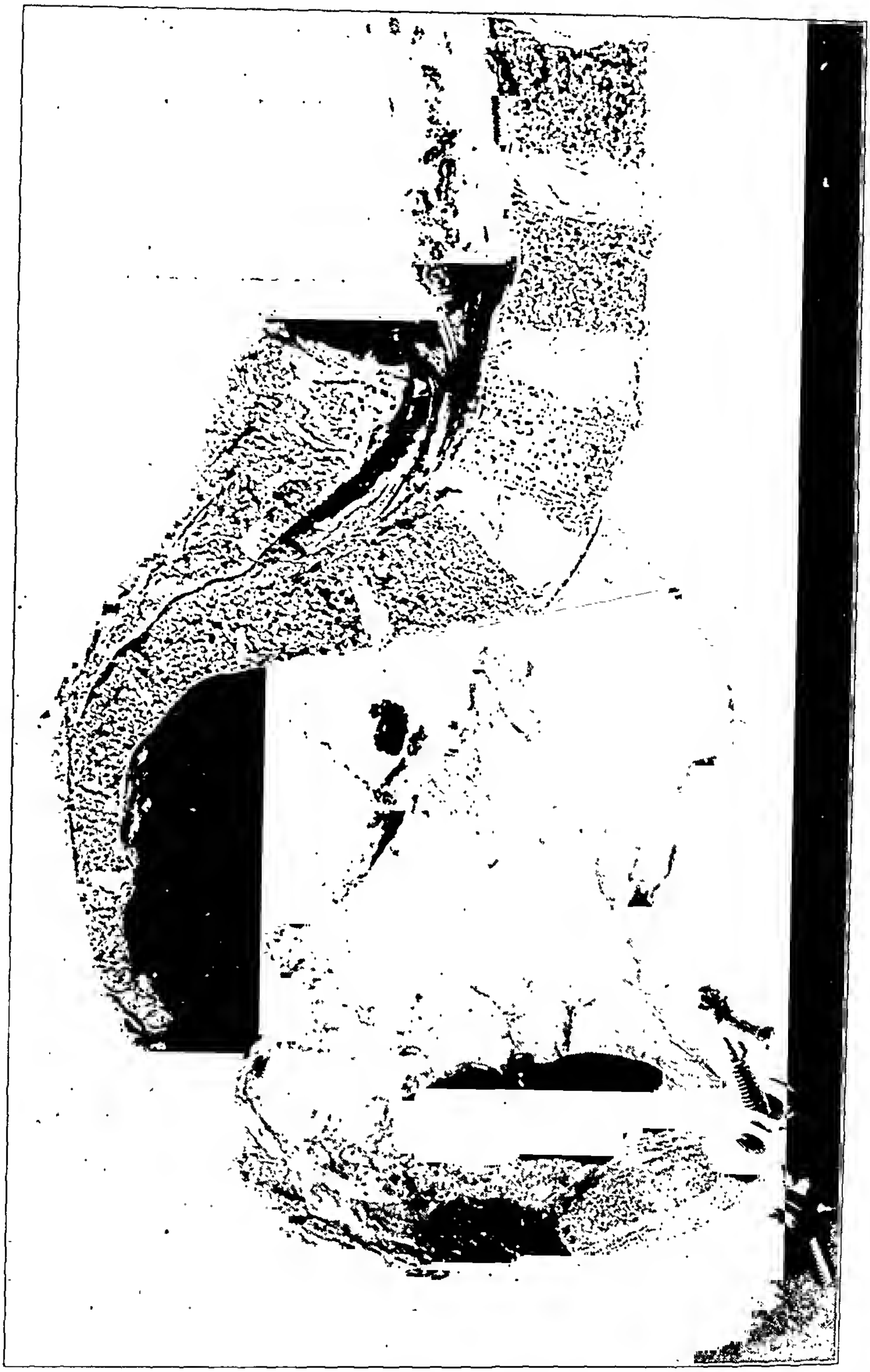

FIG. 9
For explanation see text.

angle must be due to variations in angle *LOB*. The diagram makes it clear that, if the trunk is to be held erect, angle *LOY*, which is the sum of angles *LOB* and *YOB*, must approximate a right angle. This is indeed true.

For confirmation let us analyze these figures for two typical specimens. In the first:

$<LOS = 135°$ and $<YOB = 45°$.

$<LOS = <LOB + <BOS$ (This angle is practically a constant.)

$\therefore \quad 135° = <LOB + 72°$

$\therefore <LOB = 63°$

$<LOY = <LOB + <YOB$

$\therefore <LOY = 63° + 45°$

$\therefore <LOY = 108°$

By similar calculations one finds that in the second specimen $<LOY = 105°$.

From these figures it becomes evident that in the two specimens mentioned the lumbosacral angle fails by 15 to 18 degrees (In an average of twenty-eight specimens the figure was 16 degrees) to provide complete compensation for the sacral obliquity. The remainder of the compensation necessary is provided for by the lumbar convexity, which is produced by the slight wedge form of the other lumbar vertebrae and lumbar intervertebral discs. Sometimes the correction produced by the lumbosacral angulation and the lumbar convexity exceeds the amount necessary, as is proved by the fact that in certain spinal columns a perpendicular dropped from the center of the first lumbar vertebral body falls behind the center of the first sacral vertebra. Measurements show that the more marked the sacral tilting the more important does the lumbar convexity become in aiding the lumbosacral angle to provide compensation. Whereas under ordinary circumstances the lumbosacral angle fails by only 15 to 18 degrees to provide complete compensation, it may fall short by 25 degrees or

FIG. 10
Ullmann's line.

FIG. 11

A specimen showing that Ullmann's line does not always pass anterior to the fifth lumbar vertebra in a normal spine.

more if the sacral obliquity becomes very marked, and under these circumstances a definite lumbar lordosis is usually present (Fig. 6). Except in extreme cases it is not always easy to decide whether a person's lumbar curvature is normal or excessive; a degree of convexity normal for one race might be regarded as a distinct lordosis in another, and each observer has different ideas as to what are the limits of normal curvature.

It may be imagined that too much attention has been paid to these figures, but that is a mistake, for they are of immense practical importance in a consideration of the stability of the lower spine. Especially important is the figure indicating the degree of tilting of the upper surface of the first sacral vertebra, because the more marked the inclination, the greater is the tendency for the last lumbar vertebra to slip downward and forward, and the greater is the strain on the ligaments, muscles, intervertebral disc, and articular processes. On the other hand, all things else being equal, stability at the lumbosacral junction is favored by a relatively small degree of sacral obliquity and a large lumbosacral angle.

A line drawn along the anterior surface of the first sacral vertebra normally passes well in front of the body of the fifth lumbar vertebra (Fig. 9), whereas it cuts through the body of the dislocated vertebra in all but the earliest stages of spondylolisthesis. In order that these important early stages should not be missed, Ullmann modified this test by drawing the line perpendicularly upward from the anterior edge of the superior surface of the first sacral vertebra (Fig. 10). Ullmann believes that his line never cuts through the fifth lumbar vertebra in a normal lumbosacral junction, but one cannot subscribe to this belief. In twenty-eight spines of normal cadavera which were sectioned vertically in the median sagittal plane, it was found that in one instance Ullmann's line cut through the antero-inferior part of the fifth lumbar vertebra (Fig. 11), while in three others the line missed the vertebra by the narrowest of margins. It is, therefore, clear that Ullmann's test is too delicate, in that its rigid appli-

FIG. 12
Incomplete lumbarization of the first sacral vertebra.

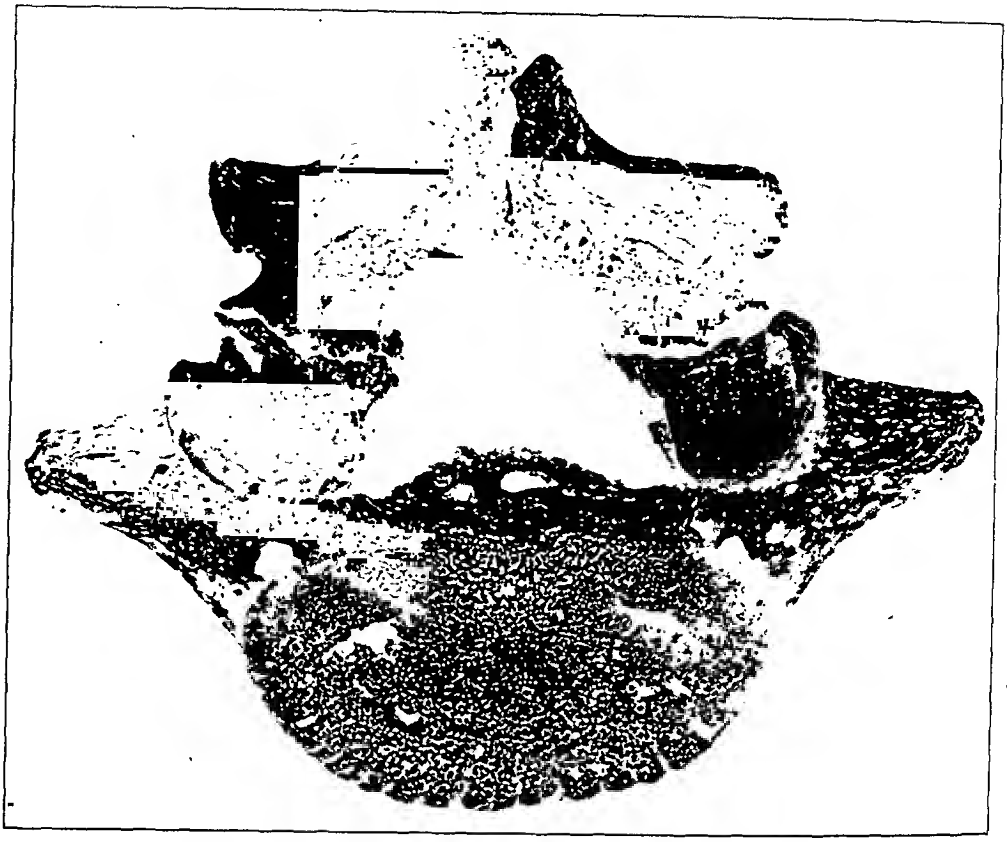

Fig. 13

Interarticular neural-arch defects of the fifth lumbar vertebra. The specimen also shows spina bifida.

cation may occasionally lead to a false diagnosis of early spondylolisthesis.

Many points have already been mentioned which explain why the lumbosacral junction is relatively unstable, as compared with the other intervertebral joints, but one has not yet exhausted all the possible causes of weakness. It is the junction of mobile and rigid parts of the spine, and such parts are potentially weak. Any relaxation or destruction of the connecting ligaments and muscles, due to injury, pregnancy, disuse, or disease, interferes with stability still further, while certain congenital abnormalities of the last lumbar or first sacral vertebrae have a weakening effect on the stability of the articulation between them. For example, asymmetrical articular processes, sacralization, and lumbarization (Fig. 12) have all been blamed, and not without cause, for upsetting the mechanics of the part and predisposing to lumbosacral lesions. Another abnormality which is quite common, but often difficult or impossible

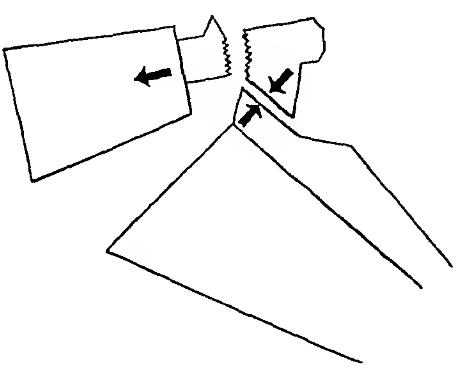

Fig. 14

A diagram illustrating how the anti-luxation action of the lumbosacral articular processes is nullified when interarticular neural-arch defects are present.

to identify in the living, is more important than any of the above in predisposing to lumbosacral derangements,—namely, unilateral or bilateral interarticular neural-arch defects (Fig. 13). The presence of such defects immediately nullifies the buttress-like or antiluxation action of the lumbosacral articular processes (Fig. 14), and thus favors the occurrence of either lumbosacral strain or olisthesis. Moreover, as Capener has pointed out, the inferior articular processes of the fourth lumbar vertebra and the superior sacral articular processes act as wedges, tending to disrupt the defective fifth lumbar vertebra, driving the anterior half of the vertebra (body, pedicles, transverse and superior articular processes) forward, and the posterior half (spinous process, laminae, and inferior articular processes) backward (Fig. 15). In this way spondylolisthesis is produced. In rare instances the inferior articular processes, laminae, and spinous process of the last lumbar vertebra are completely absent (Fig. 16), and this is the most weakening form of all the congenital defects. Von Lackum suggests that thinness of the posterior part of the lumbosacral intervertebral disc, due to the assumption of the erect posture, has diminished its effect as a shock absorber and has predisposed to injury. Others have suggested that the complete absence or abnormal smallness of the first sacral spinous process, or spina bifida occulta of the last lumbar or first sacral vertebrae, interferes with the attachments of the

FIG. 15

A preparation showing how the inferior articular processes of the fourth lumbar vertebra and the superior sacral articular processes act as wedges, tending to disrupt the neural arch of a defective fifth lumbar vertebra.

FIG. 16

A fifth lumbar vertebra showing congenital absence of the inferior articular processes, laminae, and spinous process. In some cases this appearance is produced by loss of the posterior half of a split neural arch during the process of maceration.

supraspinous and interspinous ligaments and so increase instability, but these ligaments are not of much importance in producing stability, for a dissection shows that they are very rudimentary in most cases and far from powerful in any case.

From the catalog of imperfections above given, it might appear that the lumbosacral junction must be very weak indeed, but in reality it is very powerful,—so powerful that, despite its mechanical imperfections and potential weaknesses, it is perfectly capable of supporting without strain most loads that it is called upon to bear. Nature is prodigal in her safeguards, a fact well illustrated by a consideration of the lumbosacral junction. It is built so skillfully and with such a margin of safety that, even when it is greatly modified and distorted from the original, it still remains powerful, though its safety factor is naturally decreased. Certain movements and loads, however, do prove too much for it, and not uncommonly may prove too much for one or both sacro-iliac joints also, so that lumbosacral and sacro-iliac strains are sometimes associated. A discussion of these possibilities must be left for another occasion.

SUMMARY

1. The lumbosacral junction is an extremely important region, and a study of its anatomy and mechanics explains many of the symptoms and sequelae of lumbosacral derangements.

2. Mobility at the lumbosacral junction is influenced by the shape and disposition of the constituent vertebrae and their articular processes, the resiliency of the connecting structures, the anatomical type of the individual, and, under certain circumstances, by the presence of anomalous developments or pathological processes.

3. The strength and stability of the junction are mainly dependent on the integrity of the lumbosacral intervertebral disc, the longitudinal spinal ligaments, the ligamenta subflava, and the articular processes; these processes, being arranged almost in the coronal plane, impinge upon each other when the last lumbar vertebra tends to slide downward and forward and thus prevent anterior dislocation.

4. Muscular support is singularly lacking on the anterior aspect, but the psoas major laterally and the erector spinae and multifidus posteriorly, along with other smaller and less important muscles, have an important function in the maintenance of the stability of the junction and act as "ligament sparers".

5. Much of the potential weakness of the lumbosacral junction in man is due to the skeletal modifications necessary in changing from the ancestral quadrupedal to the modern bipedal condition.

6. There is considerable disagreement concerning the size of the "sacrovertebral angle". To obviate confusion, it is suggested that the "lumbosacral angle" should be used as a standard of comparison.

7. An interrelationship exists between the degree of sacral obliquity, the lumbosacral angle, and the amount of lumbar convexity. A method is described by which these interrelationships may be calculated.

8. Ullmann's test for lumbosacral olisthesis is too delicate and may lead occasionally to an erroneous diagnosis of early spondylolisthesis.

9. A brief résumé is provided of the chief causes of weakness at the lumbosacral junction.

The writer is greatly indebted to Prof. Low for kind permission to utilize the full resources of his Anatomical Department, and for advice on a number of doubtful points.

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ARTHROSCOPY OF THE KNEE JOINT *

BY M. S. BURMAN, M.D., HARRY FINKELSTEIN, M.D., AND LEO MAYER, M.D.,
NEW YORK, N. Y.

In 1931 this *Journal* published two preliminary reports on the subject of arthroscopy. In these the possibility of direct visualization of a joint, particularly of the knee, was established by cadaver experiment and by the observation of four cases. It is the purpose of this paper to present our subsequent clinical experiences. We wish to show: first, that the fear of infection or of damage to the joint, which has been expressed both in print and in personal communications, is without foundation; that, on the contrary, arthroscopy involves only a minimal risk, and in some cases has actually had a beneficial therapeutic result, probably due to the thorough flushing and distention of the joint which it necessitated. Second, that arthroscopy is an important diagnostic aid, particularly in the case of patients who are unwilling to submit to an arthrotomy unless the surgeon can present overwhelming proof of the necessity of operation. Third, that in the group of cases where the operative choice lies between synovectomy and fusion, arthroscopy enables the surgeon to make his choice in advance,—a matter of no little moment to most intelligent patients. Fourth, that in medicolegal cases, particularly those in the compensation group, where operations have been refused, arthroscopy offers a valuable means of arriving at definite facts—instead of opinions—which in some instances have relieved the patient of the slur of malingering; in others, such facts have saved the insurance carriers a heavy loss by demonstrating a normal joint.

TECHNIQUE OF ARTHROSCOPY OF THE KNEE JOINT

For a complete description of the arthroscope the reader is referred to the original articles. Suffice it to state that the instrument consists of a trocar through which a telescope is inserted into the joint (Fig. 1). At the external end the telescope terminates in an eye-piece; at the internal end, in an electric light bulb, back of which is the lens. The trocar is equipped with two stop-cocks for distention and irrigation of the joint.

The instrument is sterilized in the same way as a cystoscope, by immersion in .05 per cent. oxycyanide of mercury for fifteen minutes. It is then washed in saline and placed in alcohol ready for use at the operating table.

The operator prepares for the arthroscopy as for a major operative procedure, by a thorough wash-up, donning of mask and of sterile gown and gloves. Sterile eye-glasses have been quite unnecessary.

* From the Hospital for Joint Diseases, Services of Dr. Harry Finkelstein and Dr. Leo Mayer.

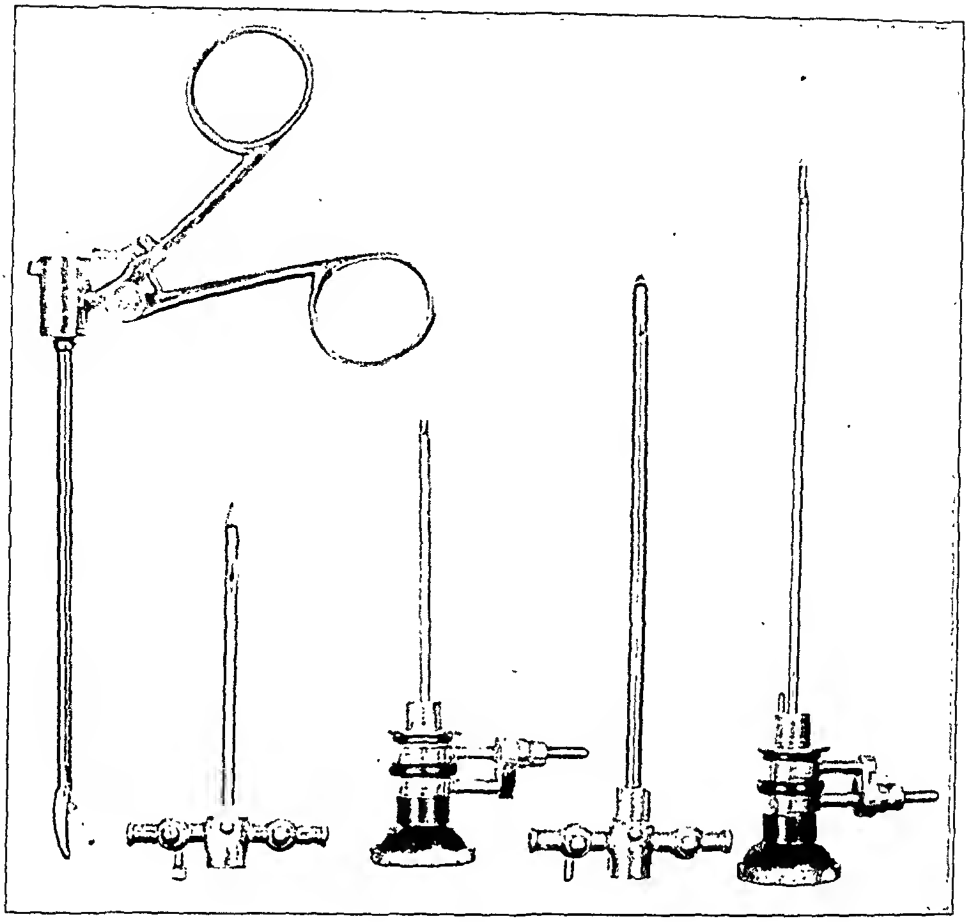

FIG. 1

Instruments used in arthroscopy. Beginning at the right they are as follows:
1. The telescope with eye-piece and electrical contact.
2. The blunt-nosed trocar with two stop-cocks for irrigation.
3. and *4.* The pointed trocar and corresponding telescope.
5. The operating instrument by means of which specimens may be removed.

The knee is draped as for an arthrotomy. It is placed on a pillow, flexed to about 160 degrees.

The steps of the arthroscopy are as follows:

1. *Anaesthesia:*

(a). *Local.* A few drops of one per cent. novocain are injected to form a wheal at a point about one-quarter of an inch external to the junction of the middle and lower thirds of the patella. The soft parts are infiltrated and twenty to thirty cubic centimeters are injected directly into the joint. If the novocain enters the joint, the entire arthroscopy is rendered painless.

or (b). *Spinal.* The latter has been used in the minority of our patients. It is indicated in cases where an operation is probably necessary immediately after arthroscopy and where the patient's consent to such a procedure cannot be secured until after arthroscopy has been done.

or (c). *General.* This is rarely advisable except in extremely nervous individuals and in children under twelve.

2. *The Skin Incision:*

An incision, one-sixteenth of an inch long, is made at the site of the wheal. When a sharp trocar is used, no incision is necessary; but we have found that trauma to the joint is best avoided by using the blunt trocar rather than the sharp.

3. *Opening the Capsule:*

This is best done with a narrow, long-bladed knife which passes into the joint between the patella and the external femoral condyle.

4. *Insertion of the Trocar:*

This follows exactly the track of the knife. This step of the arthroscopy frequently occasions difficulty until one has become experienced.

5. *Collection of Synovial Fluid:*

If excess fluid is present, this flows out through the trocar and is collected in a suitable vessel for microscopic, chemical, and bacteriological examination.

6. *Irrigation of the Joint:*

One stop-cock is connected by a rubber tube with a container holding Ringer's solution. We have found this preferable to saline, as it is more readily absorbed and causes minimal irritation to the synovial membrane. The other stop-cock is closed and the opening of the trocar is corked with the operator's sterile gloved finger. Fluid is allowed to flow in until the quadriceps pouch is moderately distended. In the living patient, the joint never balloons up as in the cadaver. Some distention, however, should always be sought for, except in cases of advanced arthritis or tuberculosis where the intra-articular adhesions are so extensive as to prevent proper filling of the joint space. The behavior of the joint during the attempt to distend at once gives valuable information regarding any pathology within it. The joint is irrigated by removing the finger from the opening of the trocar, allowing the Ringer's solution to escape, then replacing the finger and emptying again for several minutes, until the return flow is quite clear. In rare cases a peculiarly viscid synovial fluid is encountered, which is washed out only with much persistence. If this synovial fluid is left within the joint, it clouds the lens and prevents clear visualization.

7. *Introduction of the Telescope:*

First, the light is regulated by a rheostat which lowers the strength of the house current. Second, the clarity of the lens is tested by looking through the telescope at any object, either near or distant. If there is any cloudiness, the lens is cleansed with a sharpened wooden applicator. To maintain distention of the joint while the telescope is inserted, the

operator must allow a minimal time to elapse between the removal of his finger from the trocar and the insertion of the telescope. Some fluid is bound to escape, but this is replaced rapidly hy opening the inflow stop-cock after the telescope is in place.

8. *Test of the Accuracy of the Insertion:*

One glance through the eye-piece suffices as a rule to decide whether the telescope has been properly placed in the joint. If it is well within the joint, a clear picture is visible; if it is not, one sees only a reddish reflection due to contact of the light with periarticular tissues or with intra-articular fat. If a clear picture is not obtained, the trocar must be shifted until the operator is satisfied that he has reached the right spot. Of course in cases of advanced destruction of the joint, where, as explained above, distention of the joint is impossible, no clear vision can be expected.

9. *Precautions for Insuring Asepsis:*

As soon as the operator is sure the telescope is within the joint, a sterile towel is placed about the trocar and fastened in place by a single stitch which catches a bulb on the trocar located just in front of the eye-piece. After this has been done, the operator may with impunity grasp the eye-piece which until now he has carefully avoided touching, because it has been infected by contact with his face. He must, however, from this moment on remember that his gloves are no longer sterile and, if the telescope has to be cleansed, this must be done either by the nurse or by an assistant who has not handled the eye-piece.

10. *Inspection of the Joint:*

During this time there should be a constant, gentle inflow of water through the stop-cock. Inspection should be done systematically in the following order:

(a). *Undersurface of patella.*

(b). *Undersurface of patellar ligament.*

In both (a) and (b) the orifice of the telescope is pointed toward twelve o'clock, that is, directly toward the ceiling.

(c). The telescope is then turned 180 degrees, pointing toward six o'clock, to view the *anterior surface of the femur.*

(d). It is then shoved upward and inward to explore the *quadriceps pouch.* During this inspection the telescope is rotated through numerous planes, so as to get as complete a view as possible.

(e). It is then withdrawn to the original position and then, with the orifice pointing toward nine o'clock, it is allowed to slide over the anterior surface of the *inner femoral condyle.*

(f). If possible, by withdrawing gently, a view may be had of the *outer femoral condyle.* Frequently, however, this condyle cannot be seen except through a puncture over the mesial aspect of the joint.

(g). Until now the patient's knee has remained in the original

position,—namely, 160 degrees. To view the *menisci,* the knee must be gently flexed to about 120 degrees. As this is being done by an assistant, the operator shoves the arthroscope downward and inward in the direction of the middle third of the mesial meniscus. The aperture is pointed toward twelve o'clock. As a rule, there is no difficulty in viewing the anterior half of the meniscus. In arthritic joints or when the fat pads are hypertrophied, the meniscus may be obscured by adhesions or fat, which impinge against the lens.

(h). With the lens turned toward six o'clock, the upper surface of the *mesial tibial condyle* can be viewed.

(i). Next, an attempt is made to view the *anterior crucial ligament.* Although this is usually easily demonstrable in the cadaver, we have found it often difficult to see in the living, owing to the fat which envelops it.

(j). The *synovial membrane* and the *fat pads* are examined by rotating the arthroscope through numerous planes. Frequently the ligamentum mucosum is clearly demonstrated.

(k). If the operator considers it advisable to examine the *external meniscus* and the external half of the joint, the arthroscope should be withdrawn and reinserted through a mesial puncture. Before doing this, the operator should change gloves.

11. *Removal of Specimen for Pathological Examination:*

For this purpose, the conchitome described in the original article has been superseded by a new cutting instrument (Fig. 1). This is introduced through the same path as the arthroscope. Its jaws are kept closed until it is within the joint. Then they are opened, the telescope pushed forward, and the joint inspected. The visual field is about one-half that of the observation arthroscope. The specimen is removed under vision by clamping the jaws. This step of the arthroscopy requires further development, since we were frequently unable to get satisfactory views of the joint and had to remove the specimen blindly.

12. *Flushing of the Joint and Closure of the Wound:*

The original trocar is reintroduced to flush out the joint. The joint is then emptied of fluid as completely as possible by gentle pressure, the instrument withdrawn, and the nick in the skin sutured with a single stitch. A compression bandage is applied. Plaster-of-Paris is quite unnecessary.

DIFFICULTIES IN THE TECHNIQUE OF ARTHROSCOPY

Some of these are overcome with practice; others are inherent because of anatomical and physiological peculiarities of the knee. Of the first group, the site of puncture is most likely to confuse the beginner. If placed too high, the arthroscope cannot slide over the condyle to permit a view of the menisci; if placed too low, the arthroscope encounters the infrapatellar fat pad and it becomes almost impossible to enter the joint

space. As a rule, one-quarter of an inch lateral to the juncture of the middle and lower thirds of the patella marks the site of election.

Another difficulty, easily overcome by practice, relates to the proper distention of the joint. The operator should learn to place the anaesthetizing novocain within the joint proper. When successful in doing this, the patella is lifted away from the femur, making it easy to insert the trocar into the joint space. The container for the Ringer's solution must be elevated two to three feet above the patient's knee. Occasionally during an arthroscopy, when fat prolapses against the lens, elevating the container an additional foot or two will float the fat out of the way.

A third difficulty is the proper care and manipulation of the instrument. The illumination must be accurately adjusted; too brilliant a light will burn out the bulb very quickly. The lens must be kept immaculate. To cleanse the lens, a wooden applicator sharpened to a fine point has been found most efficient. Alcohol, as a rule, is the best cleansing fluid. Accurate manipulation of the instrument, so as to make it enter the desired recess of the joint, can be acquired only with practice.

Of the second group of difficulties, those inherent in the nature of the procedure, the most unpleasant is due to the presence of fat. In cadaver practice we were seldom baffled by fat; but in a number of our patients it was impossible to get a clear view of the menisci, solely because of fat pads which obtruded themselves against the lens. Usually the fat could be dislodged by increasing the pressure of the irrigating fluid or by gentle manipulation of the arthroscope. Occasionally, however, neither of these procedures was successful. A second difficulty is the presence of an oily synovial fluid which, if left within the joint, clouds the lens, making clear vision impossible. Experience has shown that it is wiser not to attempt arthroscopy in the presence of an extensive effusion. The joint should be aspirated repeatedly to withdraw the fluid and, at time of arthroscopy, very thorough irrigation is necessary to remove all traces of the oily synovial fluid.

CLINICAL STUDY

The results of thirty arthroscopies are presented. This comparatively small number is due to the fact that the authors have refrained from using the method except when uncertainty of diagnosis or of therapy justified it. In discussing the cases we shall not burden the reader with a series of statistics, but shall try by a series of illustrations to emphasize the practical value of the method.

One important observation holds good for every case. In not a single instance did the arthroscopy cause any injury to the joint which could be detected either macroscopically, when arthrotomy was performed, or microscopically, when tissues were examined histologically. In the great majority of patients there was no temperature reaction whatever; in a few the temperature rose to 101. As a rare exception it registered 102. Most of the knees showed a transient effusion, decidedly less

than that seen after an arthrotomy. The effusion invariably subsided after a few days of rest and the application of a compression bandage. In the cases where arthroscopy was followed immediately by arthrotomy, the reaction was no greater than in control cases when operation was performed without a preliminary arthroscopy. These facts seem to us to answer unequivocally those who fear the danger of infection or of damage to the joint by arthroscopy. Certainly, as contrasted with an arthrotomy, the procedure causes decidedly less reaction. In a large percentage of cases subjected to an exploratory arthrotomy, despite the utmost refinement of technique, the inflammatory reaction after arthrotomy gave ample evidence of the traumatism it caused. We abandoned exploratory arthrotomy as a means of diagnosis because we were convinced it did our patients more harm than good. Besides, in all but advanced cases of tuberculosis, the microscopic diagnosis of tissues removed at arthrotomy was negative for tuberculosis, despite the subsequent positive proof of the presence of that disease. Arthroscopy has the advantage over exploratory arthrotomy, not only in being decidedly less traumatic, but because it permits an inspection of the entire joint, whereas the exploratory operation, unless performed through a large incision, limits the view to a small portion of the knee.

Our cases may conveniently be divided into three groups: the traumatic, with particular reference to a possible meniscal injury; the arthritic, including those suspected of tuberculosis; and the miscellaneous,—intermittent hydrarthrosis, suspected tumors, sarcoid disease, etc.

Group I—Cases Involving the Menisci

It is only in exceptional instances of suspected meniscal injury that arthroscopy is indicated. As a rule, the history and physical examination are sufficient to make the diagnosis and warrant arthrotomy. In some patients, however, even the most thorough study leads to nothing but uncertainty. It is in those cases that arthroscopy is of value, particularly when dealing with a patient strongly averse to a major operative procedure. Such a patient, we have found, will readily consent to an arthroscopic examination and, if this evidences a lesion of the meniscus, it has proven the strongest argument to convince the patient that operation is advisable. Ten patients are included in this group; in eight, arthroscopy was done to clear up the diagnosis of a doubtful meniscal injury; in two, following removal of the meniscus, to determine the condition of the joint after meniscectomy. In six of the first eight patients, arthrotomy was done immediately after the arthroscopy.

The arthroscope, because of its magnification, demonstrated a pathological peculiarity of damaged menisci which hitherto has not been stressed,—the presence of fine vascular lines of hyperaemia crossing over the meniscus. These lesions were found in every damaged meniscus, except in one instance where the history and other pathological findings indicated that we were dealing with a pathological fracture. Occa-

sionally a lesion in the bone or synovial membrane adjacent to the meniscus gave rise to similar lines of hyperaemia. In a few cases the meniscal fracture could be seen better with the arthroscope than when the joint was opened. On the other hand, the arthroscope cannot detect a fracture under the following circumstances:

1. If the tear does not quite reach the superior surface of the meniscus.
2. If the fracture is obscured by overhanging fat or synovial folds.
3. If the fracture is situated beneath the posterior portion of the internal femoral condyle.

In such cases the presence of the vascular lines of hyperaemia are of considerable diagnostic importance.

The two cases in which arthroscopy was done subsequent to meniscectomy are illustrative of the value of the method in medicolegal cases.

The first patient, S. G., was a woman of forty who, five years before, had had an arthrotomy for a torn internal semilunar cartilage. The anterior half of the meniscus was removed at the Long Island College Hospital. Owing to persistence of pain, she was operated upon again a year later at the Hospital for Joint Diseases, and the posterior half of the internal meniscus was removed. Although she improved, the knee again became painful following an auto accident one and a half years later. The examination revealed slight swelling of the knee, tenderness over the medial aspect, and restriction of motion (angle of greatest extension, 170 degrees; angle of greatest flexion, 120 degrees). The patient absolutely refused to permit further operation in the knee. The insurance carrier, claiming that the patient's symptoms were largely if not entirely neurotic, insisted that compensation be discontinued. Under the circumstances, both claimant and carrier welcomed arthroscopy as a means of determining the exact status of the joint. The synovial membrane was found covered with numerous fine, injected villi, and an erosion of the cartilage on the anterior surface of the intercondylar fossa was clearly visible. There was no doubt of the diagnosis of a villous arthritis, thus disproving the diagnosis of a compensation neurosis. The court awarded the patient adequate compensation.

In the second case, the arthroscopy led to an exactly opposite conclusion.

The patient, a man of forty-two, had suffered an injury to the knee, resulting in symptoms suggestive of a meniscal injury. An arthrotomy had been done and a loose (not a fractured) meniscus removed. Despite primary union of the wound, the patient claimed that his knee remained painful. He was readmitted to the Hospital. Examination showed slight swelling, tenderness over the mesial aspect, slight restriction of motion, and a marked limp, exaggerated far beyond what the objective disturbance of the joint would lead one to expect. At arthroscopy an absolutely normal joint was found, except for a slight enlargement of the retropatellar fat pads. The patient was treated on the basis of a neurosis.

The legal settlement of this case is still pending, but it is already clear that the arthroscopic evidence will be of great importance in reaching a just decision.

Group II—Arthritic Cases, Including Tuberculosis

The indication for arthroscopy in cases of frank arthritis is usually not diagnostic but therapeutic. It helps to decide whether a joint which

has failed to respond to non-operative treatment should be operated upon and what type of operation is indicated. It is of particular value in deciding whether a synovectomy is feasible or whether arthrodesis must be done. It has been our experience that patients invariably want to know in advance whether an operation is undertaken to produce a stiff knee or whether there is a chance of securing painless motion. This seems to us a reasonable demand, particularly since, with the arthroscope, it is possible to determine before arthrotomy the exact pathology of the joint. From the diagnostic angle, the arthroscope is of value in helping to differentiate tuberculosis from arthritis.

Twelve knees of eleven patients are included in this group. Visualization was usually good. In cases of marked destruction, particularly of advanced tuberculosis with obliteration of the joint space, however, it was impossible to distend the joint, and consequently nothing could be seen. After one or two such experiences, the operator realizes their significance and can draw the correct conclusion regarding the pathology of the joint. The lack of visibility does not prevent one from taking a specimen with the operating arthroscope, although it does necessitate doing this blindly.

It was in the group of arthritic cases that we had the pleasant surprise of seeing a marked improvement in the joint following arthroscopy. This unlooked-for therapeutic effect was so marked in the case of one patient (A. B.) that after his one knee had been examined he begged us to do the same for his other knee. The case warrants citation for another reason.

The patient, a man of fifty-two, was admitted to the Hospital because of pain and swelling of the right knee. The onset had been gradual; the duration of symptoms, nine months. Since childhood he had had an ankylosed right hip, supposed to be due to tuberculosis. Examination showed the hip ankylosed in 15 degrees of adduction. The knee showed a range of motion from 180 degrees to 75 degrees, and marked swelling, due chiefly to synovial effusion. The tuberculin test was negative. The x-ray showed moderate osteo-arthritic changes. The arthroscopic findings were: abundance of fat in joint, with many villi floating freely in the joint cavity; infrapatellar fat pads enlarged and a little injected; area of recent hemorrhage on roof of quadriceps bursa; joint cartilage normal, save for a small fibrinous-covered area above the intercondyloid fossa. Part of the internal meniscus was seen, and this seemed normal. Biopsy specimen was taken and showed a non-specific chronic synovitis. The synovial effusion disappeared after the arthroscopy and the patient felt so much better that he could be discharged. Two months later he returned with a swelling of the left knee and the request that we give him the same treatment which had helped his right knee. Here also the arthroscopic examination showed a non-specific inflammation of the synovial membrane, and, as in the right knee, the swelling promptly disappeared after the arthroscopy. It seems to us that, as already stated, this improvement was due to the withdrawal of the synovial effusion and to the distention and thorough irrigation of the joint.

The case is significant also in illustrating the diagnostic method of differentiating tuberculosis from non-specific arthritis. Here we had a patient who, on his first admission, certainly gave us reason to consider the probability of a tuberculous infection. Had his tuberculin reaction

been positive, the diagnosis would have been thoroughly justified. We were able to exclude it with reasonable certainty by the arthroscopic examination and the biopsy specimen.

We want, however, to stress the fact that we are not yet able to exclude the diagnosis of tuberculosis with certainty in all cases. This is due, we think, partly to our inexperience in recognizing the early synovial changes of tuberculosis, and partly to the nature of the tuberculous process, which in some instances remains subsynovial or osseous until a later stage of the disease. We have, on the other hand, been able twice to prove a joint to be tuberculous with the arthroscope.

Group III—Miscellaneous Cases

Each one of the eight cases of this group is so distinctive as to warrant brief summary. Two were children with unusual joint manifestations, three involved traumata to the joint with peculiar manifestations and complications, two were rare types of arthritis, and the eighth was an intermittent hydrarthrosis.

Both children were eight years old. Bernice S. had had recurrent attacks of swelling, pain, and limitation of motion of the right knee for a period of three years. Each attack had lasted from two to six months. The x-ray had shown normal bone. Despite negative tuberculin and guinea-pig tests of the joint fluid, we felt that tuberculosis could not be positively excluded and were, therefore, uncertain whether to advise synovectomy or fusion. The parents, intelligent people, hesitated to consent to an operation unless we could give them more definite information. Arthroscopy was therefore advised. Visualization of the joint proved extremely difficult because of the proliferation of the synovial membrane and the presence of numerous adhesions. Several specimens were removed and, as these showed simple non-specific chronic synovitis, we felt warranted in advising synovectomy. Operation confirmed the arthroscopic findings. The child made an excellent recovery from the synovectomy and has had no recurrence of the joint disturbance.

Mildred H. had a chronic swelling of the knees, both elbows, both wrists, and of the tendon sheaths of both ankles. The knees were enormously enlarged, measuring thirteen and one-half inches in circumference. Despite the most thorough study, no positive diagnosis could be made. Because of the possibility of syphilis (Clutton's joints), she was given antiluetic treatment for several months without, however, any improvement. Since the x-ray showed a small cyst of the olecranon, this was explored but no pathology, other than simple inflammatory changes, was found. The child's appearance, the presence of lymphatic enlargement, and the anaemia, inclined our medical consultants to the diagnosis of Still's disease. Arthroscopy was done to secure further data. It showed small circumscribed red bodies attached in clusters to the synovial membrane. The joint cartilage was normal. The specimens removed were diagnosed microscopically as chronic villous synovitis. The peroneal sheath of the right ankle was then opened. It was filled with masses of spongy red tissue, similar to those seen in the knee. This tissue microscopically revealed peculiar tubercles closely resembling those seen in sarcoid disease. These differ from the tubercles of tuberculosis in the total absence of carious degeneration. Guinea-pig injection of the tissues was negative for tuberculosis. On the basis of the arthroscopy and the peroneal-sheath exploration, we felt that synovectomy was the procedure indicated. Both knees were operated upon with excellent results, and the tendon sheaths of the ankle were resected. The swelling of the elbows and wrists diminished after the lower extremities had been operated upon. There has been no recurrence of the knee swelling.

Of the traumatic cases, Evelyn H., aged twenty-three, gave a history of repeated locking of the right knee following a trauma nine years previously. Examination showed marked tenderness along the line of the internal meniscus and of the internal lateral ligament, with limitation of flexion to 100 degrees; roentgenograms were normal. A provisional diagnosis of meniscal injury was made. At arthroscopy the meniscus was found normal except for the fine hyperaemic lines previously described (p. 261). The internal femoral condyle medially was gray and opaque, and numerous fine vascular lines of inflammation traversed it. The significance of these findings was doubtful. We concluded that there was some peculiar lesion in the region of the internal meniscus, possibly an incomplete fracture or some inflammatory process. At the arthrotomy a small pannus was found over the upper medial aspect of the internal femoral condyle. The meniscus showed no macroscopic lesion except the fine vascular lines. There was a dense band of adhesions running from the internal condyle to the mesial surface of the synovial membrane; when this band was divided, a small superficial focal area of hemorrhage was noted in the bone. The patient's convalescence was slow. Only after five months of physiotherapy, including three manipulations under anaesthesia, did the knee finally regain free, painless motion.

We feel that in this case operation really retarded the patient's recovery, since we did nothing more than divide an adhesion which could unquestionably have been stretched by non-operative methods. This case illustrates both the uncertainty of diagnosis when history, symptoms, and the conventional examination seem to indicate a meniscal injury, and also how much we still have to learn about the significance of the arthroscopic findings.

The second traumatic case, also a woman, illustrates again the value of arthroscopy in cases suspected of malingering.

Helen K., aged twenty-eight, had struck her left knee about two and a half years before examination, while working as a telephone operator. The knee soon became swollen and painful. It was aspirated and splinted without relief and the knee remained painful despite considerable treatment. The knee was said to lock occasionally on walking; this may have happened twelve to fourteen times altogether. The patient stated that she had not been able to bend her knee recently. It was held in full extension and could not be flexed. The knee was slightly enlarged but was otherwise negative. A roentgenogram revealed slight bony irregularities. It was felt, following a neurological examination, that the patient was trying to capitalize her injury, that many of her symptoms were fictitious, and that a diagnosis of malingering was justified.

A manipulation of the knee without anaesthesia resulted in free and easy motion. Arthroscopy was done under local anaesthesia. It showed a moderately hypertrophied and slightly injected synovia. An area of erosion was seen on top of the intercondyloid fossa and the joint cartilage of the external femoral condyle was grayish, more opaque than normal, and traversed longitudinally by several old grooves. The surface of the joint cartilage was in general fuzzy and fibrillar. The cartilage on the undersurface of the patella was covered by thin, fine, fibrillar fuzz. The menisci seemed normal. The insertion of the anterior crucial ligament was more fibrillar and reddish than normal. A diagnosis of arthritis of the knee was made on the basis of the above findings.

To check the arthroscopic findings, an arthrotomy was also done. This confirmed in every respect what had been seen with the arthroscope.

It is evident that in this case the strong suspicion of malingering was disproved by the extensive pathological changes shown by the arthroscope.

The third case illustrates the difficulties of diagnosis even with the

aid of the arthroscope in a traumatic case complicated by very earl tuberculosis.

Sam S., aged forty-seven, had been struck a glancing blow on the left knee by a automobile ten weeks before his admission to the Hospital. The knee had been splinte at once; roentgenograms were negative. Relief had been obtained in three weeks; pai however, had continued. Examination showed that the knee could be extended to 16 degrees and flexed to the normal limit. There was a slight limp on walking. There wa some atrophy of the quadriceps. No crepitations were present on motion. The joi was tender on the external aspect. Roentgenograms at first were considered negativ comparison with the normal right knee suggested a slight osteochondral fracture of th external condyle of the tibia, the plane of the tibia being altered slightly near the tibi spines.

At arthroscopy a round, hemorrhagic mass, about one-quarter of an inch across, wa noted under the quadriceps tendon. A few fine adhesions were noted in the quadricep bursa and a few small areas of hemorrhage were noted on each side of the patella. Ther was some increase in the fatty constituents of the joint, limiting vision of the bottom o the joint. The synovia was slightly injected. The joint cartilage of the femoral condyle was normal, save for two small erosions on top of the intercondyloid fossa. The interna meniscus was seen in part and was normal. A biopsy specimen showed an old hemor rhagic synovitis.

This man, when seen three months later at another hospital, showed increase swelling of the knee and x-ray changes strongly suggestive of tuberculosis. This diag nosis was confirmed at operation and a fusion of the knee was done.

The sixth patient in this miscellaneous group was a male, aged twenty-three. H stated that swelling of the left knee had been present for three months and was not relate to trauma. Pain had begun a month before admission. Motion of the knee had alway been free. On three successive occasions a bloody fluid had been obtained on aspiratio of the knee.

Examination revealed a swollen joint which was painless, and in which motions wer normal. Roentgenograms and blood Wassermann test were negative. Coagulatio time of blood was one and a half minutes; the bleeding time, two and a half minutes. Th fragility test disclosed partial hemolysis at 0.42 and complete hemolysis at 0.38. Hemo philia could thus be ruled out, and some local condition, non-traumatic in origin, possibl an angioma within the knee joint, was believed responsible for the bleeding.

Arthroscopy was done under general anaesthesia. An excessive amount of bleeding was noted in making the usual nick in the skin. There was much blood within the joint and it was necessary to wash the joint repeatedly to allow vision. The joint was filled with a dark brown, fuzzy fibrin which occupied the entire quadriceps bursa and joint space. The internal femoral condyle was brown in color and a defect was present in its lower surface. This was covered with fibrin. The anterior crucial ligament was normal. The internal meniscus was not seen, because the bottom of the joint contained much fibrin. The synovia was reddish brown in color and increased in quantity. There was a definite enlargement of the infrapatellar fat pad. A diagnosis of hemorrhagic synovitis was made and immediate arthrotomy undertaken. Operation confirmed the arthroscopic findings and showed, in addition, polypoid-like hemorrhagic masses in the anterior external compartment of the knee.

Pathological examination of the synovia disclosed a hypertrophic synovia with much villous formation. Many newly formed blood vessels with much old blood pig- ment and some giant cells were located in the synovia. The vascular appearance did not resemble an angioma and the condition is believed related to a polymorphocellular xanthoma-like or angioma-like lesion, occasionally encountered in tendon sheaths and joints, especially in the knee. The lesion is not a true tumor. Smear of the synovia revealed many red cells, few white cells, and no bacteria. Culture of the synovia was sterile.

Convalescence was uneventful. An immediate postoperative rise to 101.6 degrees was noted and for four days the temperature ranged between 100 and 101 degrees. From the fifth to the twelfth days after operation, it ranged between 99 and 100.2 degrees.

This patient was observed for a year after operation. The motion of the knee gradually returned and eventually became normal. There was no recurrence of the swelling.

Here the arthroscope enabled us to make a preoperative diagnosis of a peculiar type of hemorrhagic synovitis and gave a definite proof of the advisability of a synovectomy.

In the seventh patient, a woman of thirty-seven years, pain and swelling had developed after a mild trauma one year previously. After aspiration, symptoms had subsided; but a second attack followed nine months later, and a third six weeks before admission. The examination showed a limp, angle of greatest extension 170 degrees, angle of greatest flexion 40 degrees, slight enlargement of the joint, and tenderness along the line of the internal meniscus. The roentgenograms were negative; so too were the general examination and laboratory data. The diagnosis lay between a meniscal injury and a monarticular arthritis. At arthroscopy it was difficult to enter the joint but, by an oblique puncture, the quadriceps pouch was entered. It was found filled with reddish inflamed villi. The synovia was acutely inflamed and hypertrophic. The undersurface of the patella was fuzzy and fibrillar. Even without examination of the rest of the joint, it was possible to diagnose a villous synovitis. It was decided to attempt a cure by immobilization but, despite a temporary improvement by this method, recurrence of pain necessitated synovectomy five months later. This confirmed the diagnosis of hypertrophic synovitis and showed, besides, peculiar white deposits over the femoral condyles, menisci, and synovial membrane.

Microscopic examination revealed unusual bodies in the synovial membrane resembling Hassall's corpuscles. The patient made a good recovery. At follow-up examination seven months later, the knee was found painless, with motion from 180 degrees to 90 degrees, and the patient walked without a limp.

The arthroscope again gave valuable evidence in differentiating a possible meniseal injury from a monarticular arthritis of meniscal type.

The final case, a woman of twenty-nine, had had an intermittent hydrarthrosis for six years. The swelling appeared at intervals of two to four weeks and lasted four to seven days. During the attacks the patient had slight pain necessitating rest in bed. The physical examination was quite negative and all tests were negative. She was unwilling to have an operation but consented to an arthroscopy. The quadriceps pouch showed definite inflammation of its lining with some deposition of fibrin. The synovia was slightly injected. The cartilage of the patella was quite normal. No meniscal injury could be detected. The patient left the hospital after two days, and since the arthroscopy has had no return of the effusion.

Whether this result should be attributed to the distention and thorough irrigation of the joint or to some coincidence cannot be decided until other similar cases are accorded the same treatment. After this experience, we feel that, in cases of intermittent hydrarthrosis, arthroscopy should certainly be done before synovectomy is considered imperative, since it not only may give important diagnostic data but may prevent the recurrence of the attacks.

SUMMARY

In this paper the technique of knee arthroscopy is given in detail

and thirty cases are summarized to indicate the value of the procedure. Arthroscopy can be done without fear of infection or of trauma to the joint. It has the advantages of a diagnostic arthrotomy without necessitating operation, and it is, therefore, applicable to many cases in which operation is either not permitted or inadvisable. It has, however, difficulties, some inherent in the method, others in the technique, which necessitate the most thorough cadaver practice before arthroscopy should be attempted on a patient. The authors are keenly aware of the present imperfections of arthroscopy, and one purpose of this presentation is to elicit the active help of their colleagues in perfecting this new diagnostic method.

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TUBERCULOSIS OF THE SHAFT OF LONG BONES*

A Report of Six Cases†

BY GEORGE W. VANGORDER, M.D., F.A.C.S., BOSTON, MASSACHUSETTS

In the Orthopaedic Clinic of the Peiping Union Medical College Hospital, China, during the years 1927 to 1929, six cases of tuberculosis of the shaft of bone were admitted to the writer's Service and were thought to be of sufficient interest to record.

Case 1. A Chinese girl of nine years entered the hospital August 15, 1927, with a history of swelling of the left fourth finger and left forearm of eight months' duration. The onset of the finger condition was a local injury, while that of the forearm was insidious.

The patient was first seen in the Out-Patient Department four months previous to admission and was treated during that time in the Syphilis Clinic on the basis of the roentgenographic findings. Repeated Wassermann tests, however, were negative, and four months of antiluetic treatment, in the form of neoarsphenamine injections, showed the bone condition to be getting worse rather than better. Moreover, an abscess of the soft parts of the forearm appeared which, upon aspiration, showed a culture growth of hemolytic streptococcus. Because of this finding, the child was referred into the Hospital for drainage of what was then thought to he pyogenic osteomyelitis. Incidentally, she appeared healthy and had no fever.

Family history was negative both for syphilis and for tuberculosis. Past history was irrelevant.

Physical Examination: Except for the local surgical condition, the general physical examination was not remarkable. Lungs were clear. The left forearm showed definite enlargement, as compared with the right, and at its upper and lower thirds were swellings resembling abscesses, which were somewhat tender to palpation. The remainder of the forearm, though enlarged, was not tender. The elbow and wrist joints were normal.

The fourth digit of the left hand showed enlargement of its proximal phalanx with two small sinuses discharging pus. Upon palpation and motion it was remarkably free from pain.

Diagnosis: While the patient was being treated in the Out-Patient Department, the clinical diagnosis was tuberculosis, rather than syphilis. This was based largely upon the general appearance of the lesions, together with the negative family history for syphilis, and the repeated negative Wassermann tests. Roentgenographic diagnosis, however, favored syphilis, though it mentioned the possibilities both of tuberculous and of pyogenic osteomyelitis. On the basis of the x-ray findings, antiluetic treatment was tried as a therapeutic test but failed to show improvement. Finally abscess formation became apparent, and when, upon aspiration, a culture of hemolytic streptococcus was obtained, it was felt that the diagnosis of pyogenic osteomyelitis was definitely established, and the patient entered the Hospital with this diagnosis.

Operation: Incision and drainage of abscesses of left ulna for chronic osteomyelitis.

Procedure: Incisions were made over both prominent areas through a thickened but apparently intact periosteum to definite localized abscess cavities in the bone, which were carefully curetted and washed out with Dakin's solution. The gross pathology of both abscesses was exactly the same. The wounds were left open and treated with Dakin compresses. They healed readily and remained healed, as is shown by the photograph taken two years later (Fig. 3).

Postoperative Laboratory Findings: Bacteriological reports on two cultures taken

* Received for publication September 15, 1933.

† From the Orthopaedic Division of the Department of Surgery of the Peiping Union Medical College, Peiping, China.

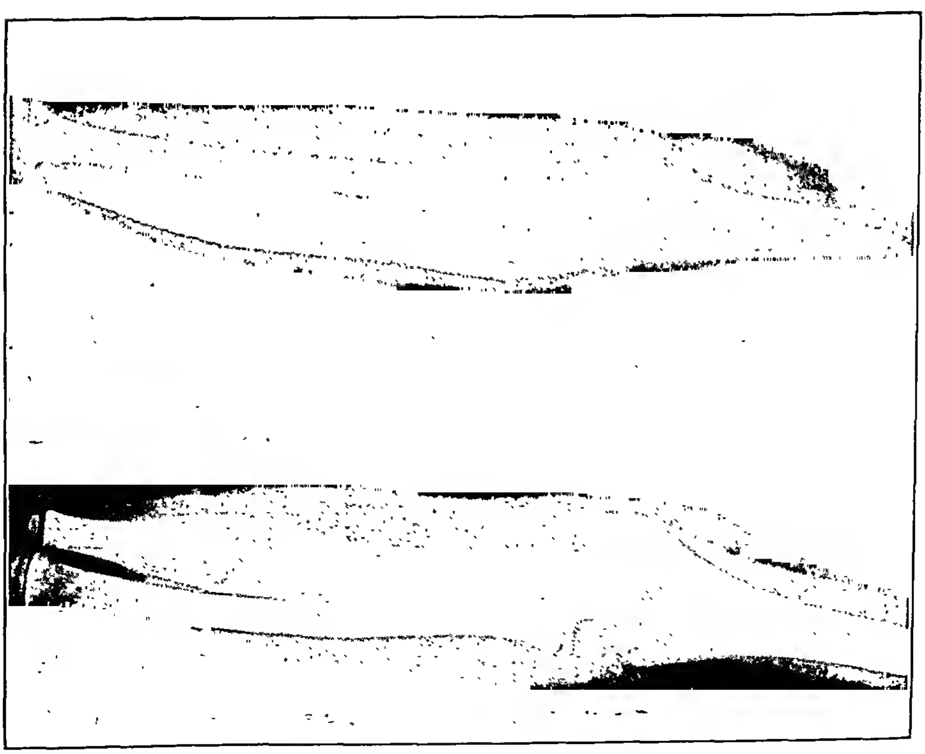

FIG. 1

Case 1. Roentgenograms taken at time of first examination.

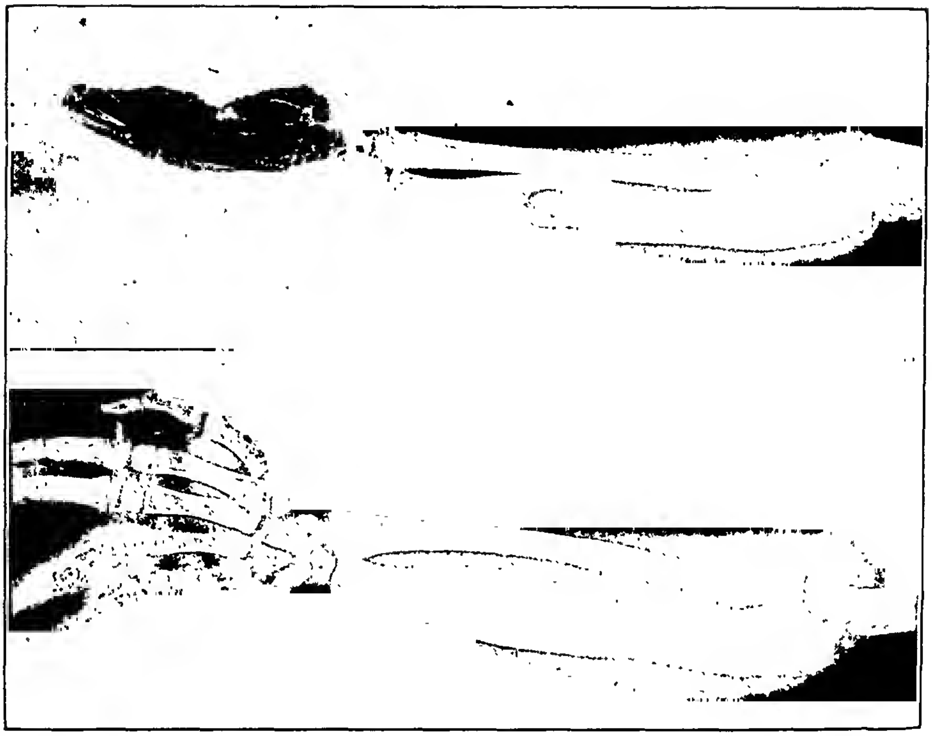

FIG. 2

Case 1. Roentgenograms taken three months later, before operation.

from the wounds at the time of operation were conflicting; one culture showed a growth of hemolytic streptococcus and the other showed no growth of organisms.

The pathological report was as follows: "Sections show fibrous and granulation tissue containing many small and large tubercles consisting of epithelioid cells and giant cells".

Pathological Diagnosis: Tuberculosis.

Fig. 3

Case 1. Two years after operation.

Case 2. A Chinese boy of eighteen entered the Hospital October 11, 1927, complaining of a swelling of his left forearm of two months' duration. The onset had been gradual and was not accompanied by any signs of acute inflammation. There was no history of injury.

Physical Examination: Except for the local surgical condition, physical examination was not remarkable. In the mid-portion of the left forearm was a tender, localized, fluctuant abscess, measuring five by eight centimeters. The skin over it was tense, shiny, and slightly inflamed. Blood, urine, and Wassermann reactions were negative.

Diagnosis: When the patient was first seen in the Out-Patient Department, before the formation of the abscess in the soft parts, a diagnosis of bone tumor was made. This was later changed to "bone abscess". The x-ray diagnosis was "abscess of the middle third of the left ulna, probably tuberculous".

Operation: Excision of bone abscess of left ulna.

Procedure: A pneumatic tourniquet was used. Incision was made over the prominence of the tumor and carried down to a pocket of pus which had formed in the muscle layers just outside the bone. The incision was then carried deeper to the bone, where three cloacae were found draining a central cavity in the middle of the shaft of the ulna.

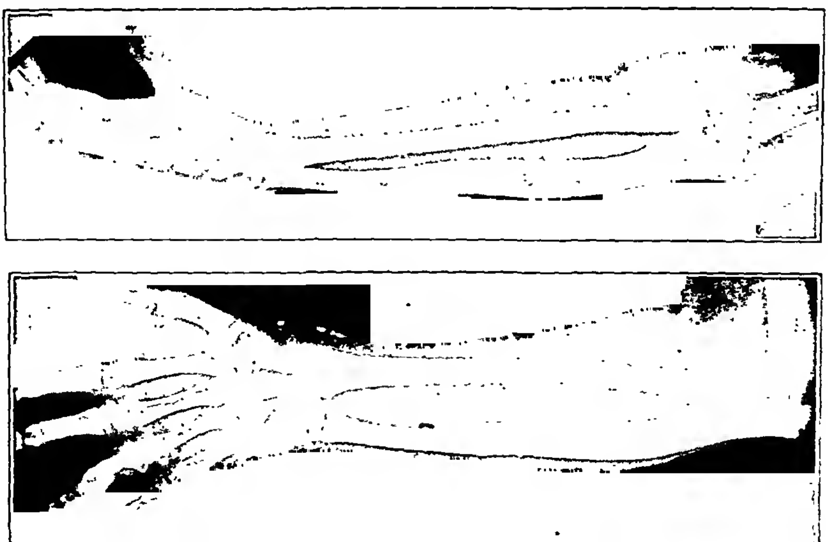

Fig. 4

Case 1. Roentgenograms two years after operation.

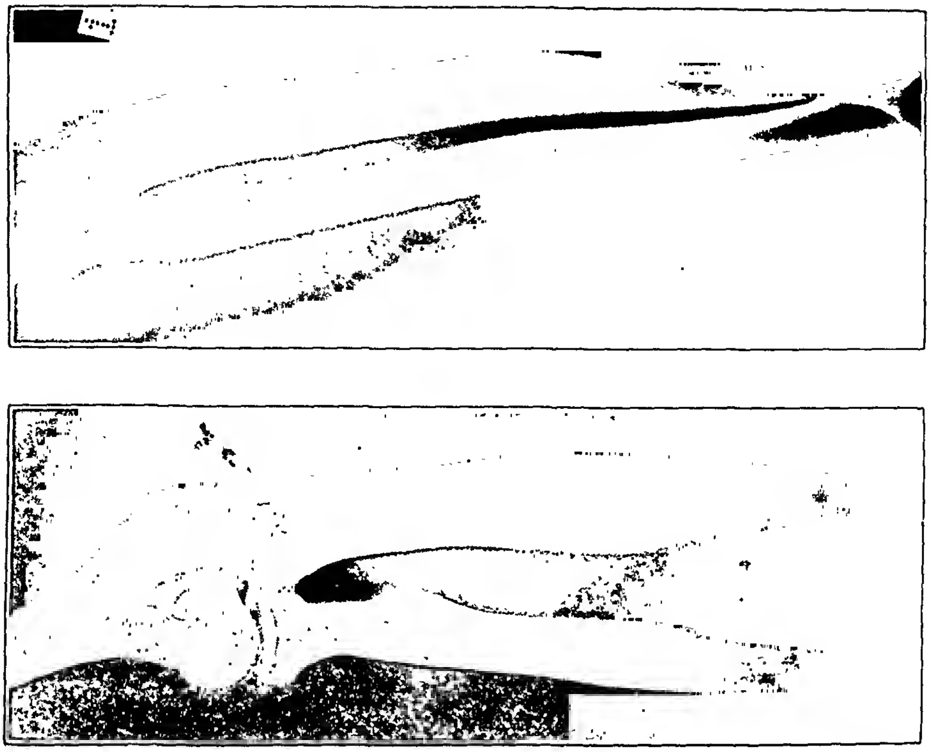

Fig. 6

Case 2. Roentgenograms fifteen months after operation.

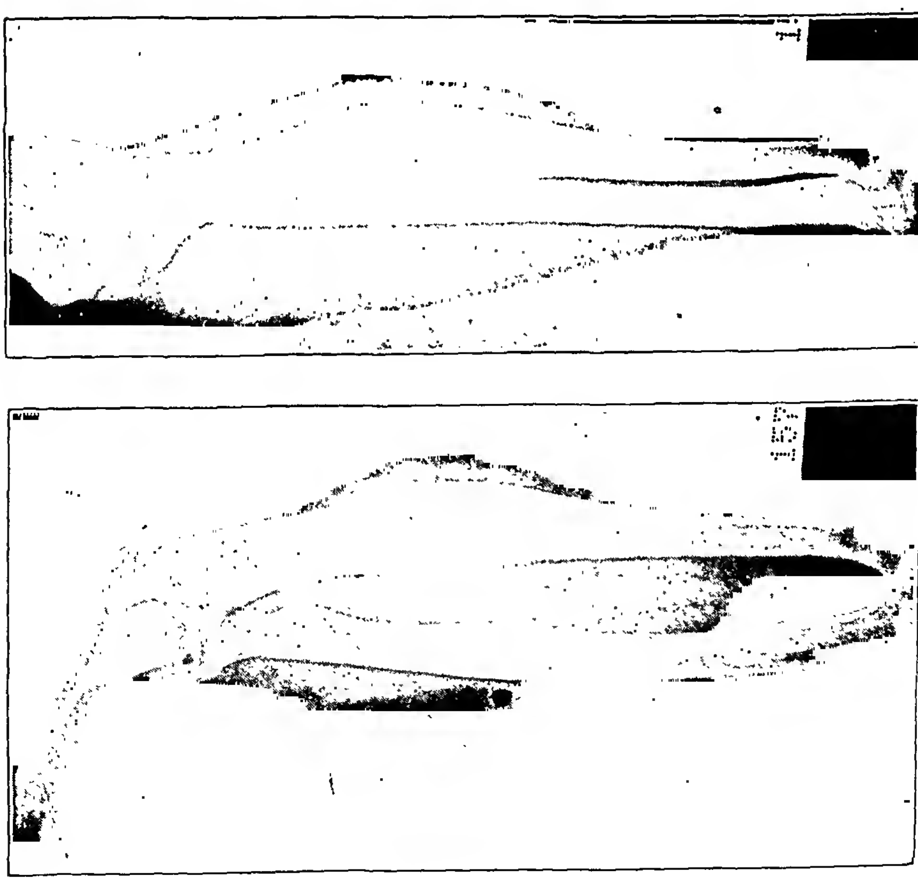

Fig. 5

Case 2. Roentgenograms before operation.

Uncovering this cavity showed a smoothly lined pocket in the bone, filled with a gelatinous material which was rubber-like and somewhat caseous. Wound was closed without drainage.

Following operation, the wound healed *per primum* and remained healed for fifteen months, when the patient was last seen.

Postoperative Laboratory Findings: Laboratory reports on the materials obtained at operation showed no bacterial growth from the pus and positive evidence of tuberculosis in the pathological sections.

Case 3. A Chinese girl of twelve was admitted to the Hospital on April 19, 1928, complaining of an oval swelling at the lower end of her right radius, which was first noticed several months previously, and which had slowly but steadily increased in size. There was no history of pain or marked tenderness associated with it, and no history of trauma.

Family history was negative; past history, irrelevant.

Physical Examination: Examination showed nothing remarkable outside of the local surgical condition. The right forearm showed two localized swellings,—one four centimeters above the wrist on the radial side, and the other at the mesial aspect of the elbow. The wrist swelling measured two and one-half by three and one-half centimeters and was moderately tender to pressure. It felt slightly warmer than the surrounding skin areas and was also softer in consistency and somewhat reddened. The elbow lesion appeared very definitely to be an enlarged epitrochlear gland which was breaking down. Movements of both wrist and elbow were painless and unrestricted.

Diagnosis: The clinical diagnosis was abscess of the right forearm of unknown etiology, with associated epitrochlear adenitis. Roentgenographic diagnosis was abscess of the right radius and expansion of the shaft of the fifth metacarpal with cortical absorption here and there, combined with periosteal elevation. The X-Ray Department considered the possibilities of the lesions being either pyogenic or tuberculous in origin, but favored tuberculosis as the final diagnosis. Additional roentgenograms showed mild pulmonary tuberculosis, but no bone lesion about the elbow joint.

Operation: Incision and curettage of abscess of right radius.

Procedure: Incision made over the lower swelling led down to considerable tuberculous exudate that lay between the muscle layers and the bone, and helped to form the abscess which was just proximal to the wrist joint. The abscess and an adjacent shallow bone cavity on the palmar surface of the radius were carefully eradicated. Wound was closed without drainage.

Following operation, the wrist wound healed *per primum*, but the epitrochlear gland gradually broke down.

Postoperative Laboratory Findings: Cultures of the pus from the operative wound and from material obtained at operation all showed no growth of organisms, and guinea-pig inoculation was positive for tuberculosis.

Follow-Up: Fifteen months after operation, the wound at the wrist had remained healed, and the epitrochlear gland lesion was also healed. Function was perfect (Fig. 9).

Case 4. A Chinese boy, aged eleven, entered the Hospital September 14, 1928, with a discharging sinus in the region of his left elbow joint. His history showed that, five months before, he had begun to have some pain in the involved area, and later a localized swelling that grew steadily worse until it spontaneously ruptured, discharging pus.

Family history and past history were irrelevant.

Physical Examination: Except for the condition of the left forearm, the general physical examination was entirely negative.

Over the posterior surface of the left ulna, adjacent to the elbow, was an ulceration measuring two by three centimeters, with a discharging sinus in its central portion. The entire left forearm was noticeably larger than the right, and palpation showed that the

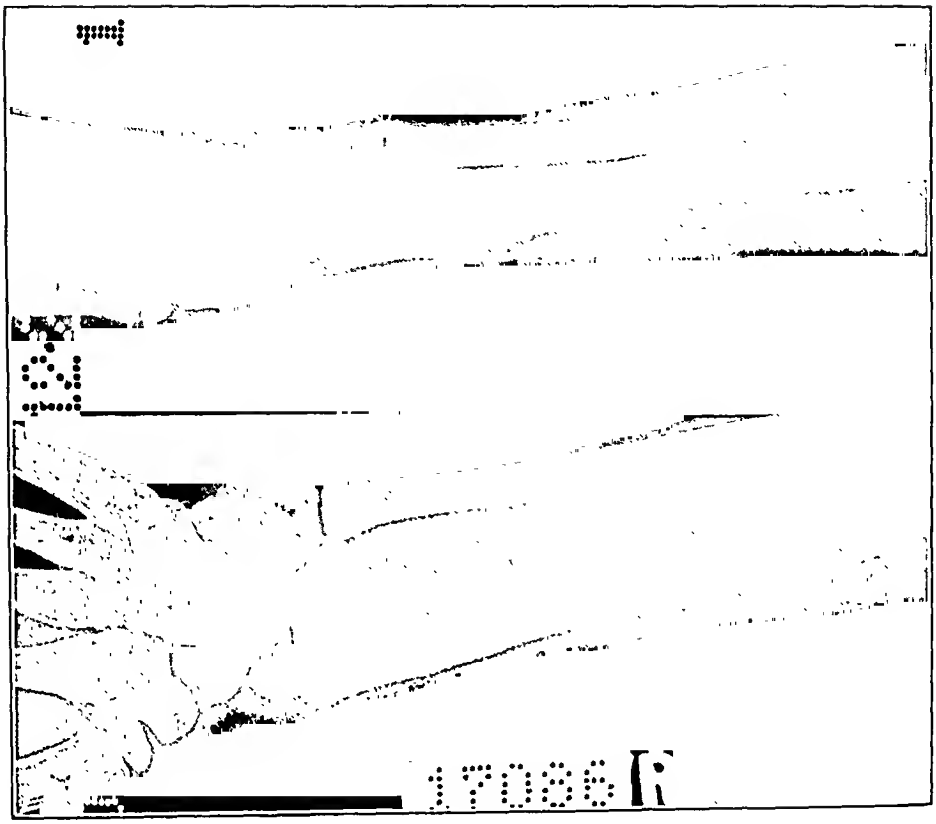

Fig. 8

Case 3. Roentgenograms fifteen months after operation.

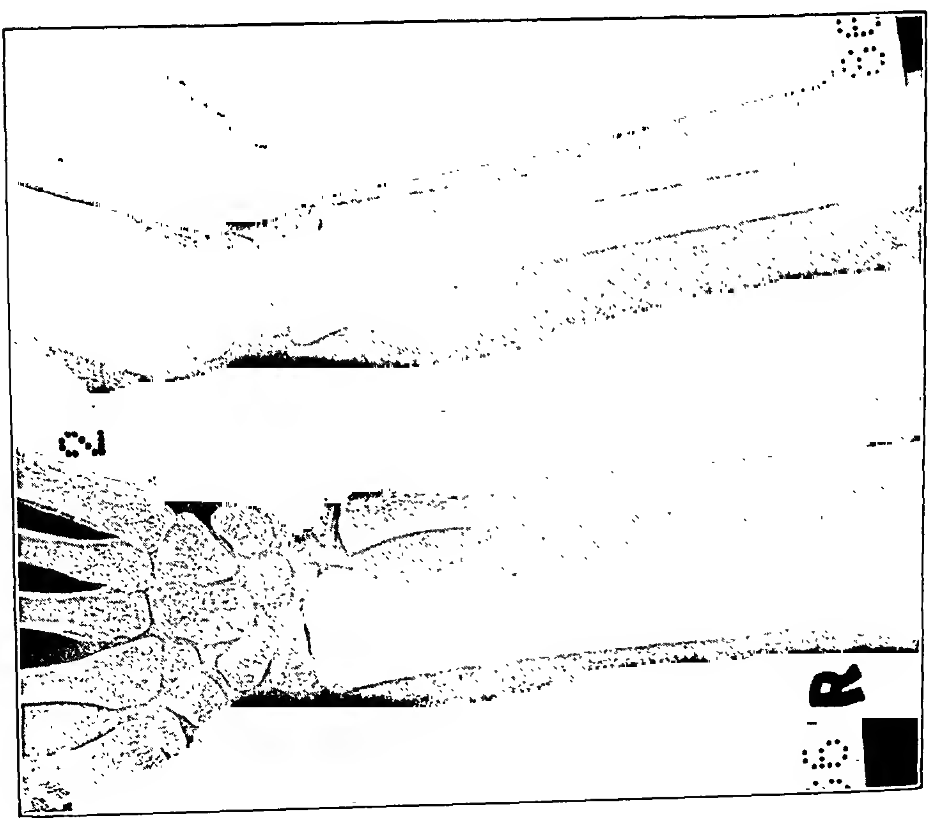

Fig. 7

Case 3. Roentgenograms before operation.

entire shaft of the ulna was thickened and slightly tender. Movements of the elbow joint showed slight restriction in all directions, but no pain.

Diognosis: A clinical diagnosis of chronic pyogenic osteomyelitis of the left ulna was made before roentgenographic examination. X-ray diagnosis included the possibilities cf pyogenic osteomyelitis, tuberculosis, and neoplasm, but definitely favored tuberculosis with multiple abscesses involving the entire left ulna.

Operotion: Excision and drainage of multiple abscesses of the left ulna.

Procedure: A longitudinal incision was made over the entire length of the left ulna, exposing the shaft which was found to be thickened and filled with multiple abscesses. The proximal end contained a great deal of granulation tissue and a slight amount of caseous material. After reflecting the periosteum, a long trough was created by chiseling off the cortex of the entire bone. Pus was evacuated, and the marrow cavity thoroughly cleaned out and swabbed with mercurochrome solution. The wound was left wide open and packed with sterile vaselin gauze. Dry sterile dressings were used. A circular plaster cast was applied from the fingers to the axilla, with the elbow joint in the right-angle position.

After ten days, a new cast was applied, but the vaselin packing was not disturbed. Orr's treatment was continued until the wound was completely healed, seven months after operation (Fig. 11).

Postoperotive Laborotory Findings: Pathological sections of the material obtained at operation showed many small and large tubercles of epithelioid cells and giant cells, as well as areas of necrosis and caseation.

Diognosis: Tuberculous osteomyelitis.

FIG. 9

Case 3. Fifteen months after operation.

CASE 5. A Chinese girl of twenty-one entered the Hospital March 13, 1929, complaining of pain and swelling of the left elbow joint, of one and a half months' duration. There was no history of trauma. Pain was slight but persistent and had no definite relation to movements of the joint. There was never any redness or increased local heat. The condition had been steadily getting worse.

The family and past history were irrelevant.

Physical Examination: The general physical examination showed nothing unusual. The local surgical condition showed a diffuse swelling over the posterior surface of the elbow with definite fluctuation over the olecranon bursa, which was exquisitely tender and slightly hot. Motions of the joint were not limited, but a little guarded.

Diognosis: The clinical impression before roentgenographic examination was olecranon bursitis, with a question of associated bone pathology. X-ray diagnosis was "Tuberculosis of proximal end of left ulna with early abscess formation".

Operation: Excision of abscess of left ulna.

Procedure: A pneumatic tourniquet was applied and an incision, eight centimeters long, was made over the olecranon bursa. Upon cutting through the skin, about twenty cubic centimeters of chocolate-colored fluid escaped. The incision was deepened down to the bone, where it was found that the medial side of the olecranon was thickened and roughened. After the periosteum had been carefully reflected, the bone abscess previously seen by x-ray was unroofed and about two-thirds of the thickness of the ulna was removed in order to completely eradicate it. Great care was used not to enter the joint

cavity. After the wound was swabbed out with mercurochrome, it was closed in layers without any drain. A plaster cast was applied with the elbow held in the right-angle position.

Following operation the wound broke down, but healed three months later, and remained so for one year, when the patient was last seen (Fig. 14).

Postoperative Laboratory Findings: The reports of the material sent to the laboratory were negative for culture growth and positive for tuberculosis by guinea-pig inoculation.

CASE 6. A Chinese male of twenty-one entered the Hospital April 3, 1929, complaining of a swelling in the upper third of his left tibia. His trouble began about fifteen months previous to admission, when he had pain for three weeks in the upper third of his left leg, followed by a local swelling. There was no history of trauma.

The family and past history were irrelevant and there was no known history of tuberculosis.

Physical Examination: The general physical examination showed some evidence of pulmonary tuberculosis at the right apex, a greatly enlarged and nodular epididymis, and fusiform swellings over the first right metacarpal, third left metacarpal, and dorsum of the left foot. All of these lesions resembled both tuberculosis and syphilis.

The surgical condition for which the patient came to the Hospital was located over the mesial aspect of the left tibia at its upper third, where there was a bone-hard, smooth, painless swelling, the size of a duck's egg, intimately associated with the bone.

Diagnosis: The clinical impression of this case before roentgenographic examination was tuberculosis or syphilis. X-ray diagnosis was tuberculosis.

Operation: Excision of abscess of the left tibia.

Procedure: Under spinal anaesthesia a pneumatic tourniquet was applied. A longitudinal incision was made a little to the medial side of the prominent bony swelling. After cutting through the skin, fascia, and muscles, the periosteum was incised and reflected, revealing two tiny holes, two centimeters in diameter, on the medial side of the bone. The bone-abscess cavity, containing caseous material, was unroofed. After the abscess cavity had been totally removed, the wound was swabbed with mercurochrome solution and closed tightly in layers.

Postoperative Laboratory Findings: The laboratory report on the material obtained at

FIG. 10
Case 4. Roentgenograms before operation.

operation showed no bacterial growth on culture, and positive evidence of tuberculosis in the pathological sections.

DISCUSSION

The Clinical Picture:

We know that tuberculosis of the osseous system shows a marked predilection for the earlier years of life, and this rule holds true in the case of tuberculosis of the shaft of bone. In this series of six cases, the ages of the patients ranged from nine to twenty-one years.

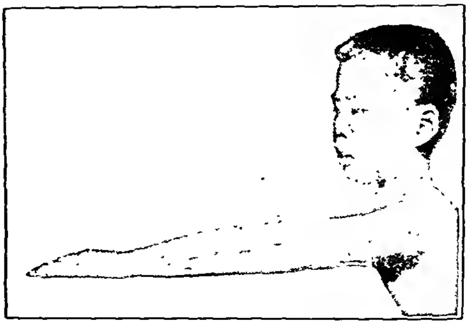

Fig. 11
Case 4. Seven months after operation.

That shaft tuberculosis does occur in adults was shown by Ragolsky [1] who reported a case of tuberculosis of the shaft of the femur in a male of forty-five years, but such instances are exceedingly rare.

The clinical features of the disease have been well described by Fraser [2], and are manifested by: (1) local thickening of the affected bone, (2) pain, (3) muscular wasting, (4) abscess formation, and (5) sinus formation in the late stages. Other lesions of tuberculosis either in bone or in other parts of the body are sometimes associated, as is shown by one-half of the cases of this series. Case 1, for instance, had an additional tuberculosis lesion in the shaft of the proximal phalanx of the ring finger of the left hand; Case 3 had an additional tuberculous focus in the shaft of the fifth metacarpal bone of the right hand; and Case 6 had other lesions of tuberculosis in the metacarpal bone, tarsal bones, epididymis, and lungs.

Tuberculosis of the shaft of a bone can hardly be said to have a characteristic clinical appearance, because it may simulate any thickening of bone, such as is found in pyogenic osteomyelitis, syphilis, or neoplasm. In its early stages, before the periosteal proliferation becomes osseous, the local swelling may be yielding and indentable to pressure; but, as ossification proceeds, it becomes as hard as healthy bone; later, if the abscess breaks through the bony shell into the soft parts, it becomes fluctuant. Palpation of the affected bone may show any one of these clinical condi-

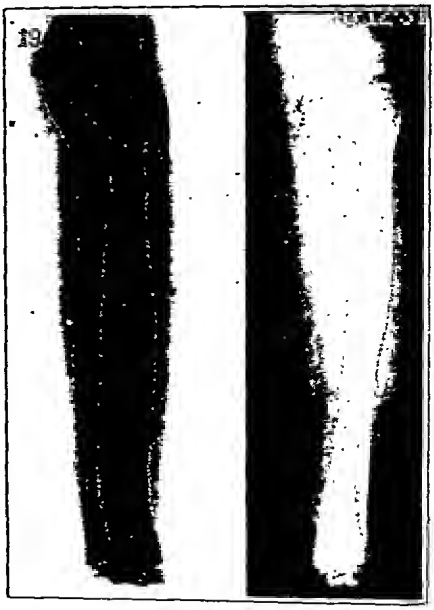

Fig. 12
Case 4. Roentgenograms three years after operation.

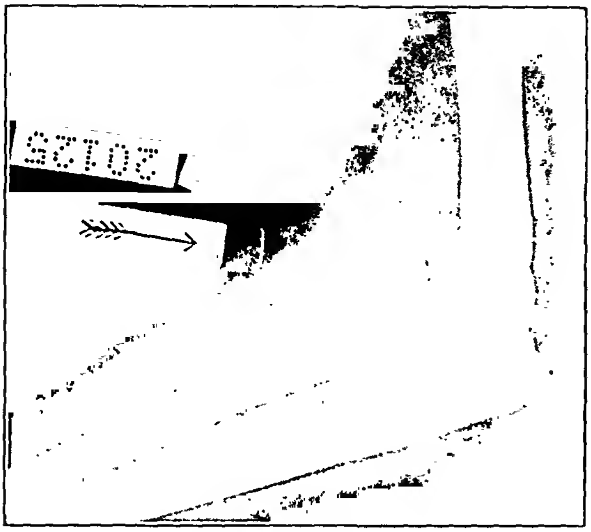

Fig. 13
Case 5. Roentgenogram before operation.

Fig. 14
Case 5. One year after operation.

Fig. 15
Case 5. Roentgenogram one year after operation.

tions, depending upon the stage of the disease.

The enlarged shaft is not noticeably tender to pressure as a rule, and there is no increased local temperature or redness until the formation of soft-part abscesses.

Pain, as a symptom, is variable in shaft tuberculosis. Frequently it is entirely absent and, as a rule, is only slight, but in certain cases pain may be a prominent symptom. The reason for this, according to Fraser, is that, when the disease is confined to the interior of the bone, the slow progress of the infiltration precludes any degree of sudden tension; but, as the bone abscess further develops and approaches the cortex, a serous effusion takes place beneath the periosteum, which exerts tension upon the nerve endings and temporarily results in local pain. A second possibility for the cause of pain may be that the tuberculous infiltration in certain cases extends more rapidly than usual, producing an increased interosseous tension, such as is present in acute osteomyelitis.

Whatever may be the exact cause of pain in these exceptional instances, it would seem fair to assume that the presence or absence of pain might be accounted for on the basis of (1) the location of the lesion, and (2) the rapidity of its extension.

Muscular wasting, although present to a moderate degree in shaft tuberculosis, is not an outstanding feature. It is much less marked than in cases of joint tuberculosis and is probably dependent upon the degree of disuse of the part.

Abscess formation takes place in tuberculosis of the shaft of bone as the local process of softening and caseation progresses in the interior of the bone, and is one of the outstanding characteristic features of the disease. It was present in all of the cases of this series, but is usually not recognized clinically until periosteal proliferation gives evidence of bone thickening or until the abscess breaks out of its bony shell into the surrounding soft parts.

Sinus formation is seen only in the late stages of the disease, when the bone abscess has extended into the soft parts and later worked its way to the surface of the skin. Just previous to rupture, the lesion shows all of the signs of an acute abscess with local tenderness, increased local heat, and fluctuation.

The general physical examination of patients with tuberculosis of the shaft of bone is not striking. Outside of other manifestations of tuberculosis, which may be present and act as a lead, there are no characteristic diagnostic signs or symptoms beyond the local lesion. As a rule, there is no fever and no leucocytosis, and the general health is not disturbed. Thus, from the clinical picture alone, it is difficult to establish with any certainty the diagnosis of tuberculosis in the shaft of a bone.

The Pathological Picture:

As a result of his attempt to establish experimental foci of tuberculosis in various regions of the bones of young dogs, Allison [3] found it possible to grow such foci in the epiphysis, in the metaphysis, in the diaphysis, in the cortex of the shaft, and on the joint surfaces.

A study of the cases in this present series gives evidence of the fact that, in human beings also, tuberculous foci may develop in various regions of the shaft of bone.

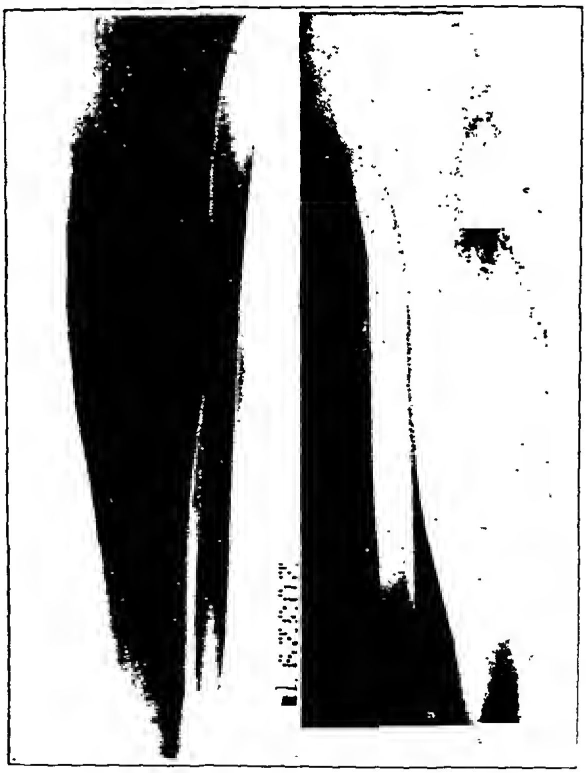

FIG. 16

Case 6. Roentgenograms before operation.

Case 1 of this series is a good illus-

tration of the pathological evolution of typical lesions of tuberculosis in the shaft of bone as seen by successive x-ray examinations (Figs. 1 and 2). It will be noted that soon after the focus of infection became established in the interior of the bone, the periosteum began to show a reaction of proliferation that continued until the tuberculous foci were completely walled off by thickened bone lamellae and zones of hyperostosis or endosteal thickening, which obliterated the adjacent medullary canal and completely isolated the abscesses from the remainder of the bony shaft.

Further study of these cases shows that the bone abscesses thus formed may either remain localized in the interior of the shaft, as in Case 1, or extend from the medulla to the periphery and later invade the soft parts. Five cases out of the six in this series had progressed to the point of penetration of their bony shell with involvement of the adjacent soft tissues, and in one case had gone on to sinus formation.

The operative notes on these cases give a fair description of the surgical pathology found. Where the soft parts were not involved, the periosteum over the bone abscess was seen to be thickened and intact. Beneath this, the cortical layer appeared softer and more porous than normal, the degree of porosity depending upon the proximity of the abscess wall. Unroofing the cortical layer revealed the sharply defined abscess cavity which, in some instances, contained fibrous and gelatinous tissue and, in others, caseous material and pus.

Where the bone abscess had broken through into the soft parts, the periosteal and cortical layers were found to be perforated, the latter being thin as a shell with cloacae running through it.

Fraser [2], in describing the gross pathological varieties of osseous tuberculosis, classifies them into four different types: (1) the encysted tuberculous lesion, (2) the infiltrating tuberculous lesion, (3) the atrophic tuberculous lesion, and (4) the hypertrophic tuberculous lesion. He later states, in a foot-note, that the last type (hypertrophic) should not be included as a classification, as he now considers it primarily a syphilitic infection, secondarily infected with tuberculous disease. According to him there are, then, the three remaining varieties of shaft tuberculosis.

The first variety (encysted tubercle) is the most common and the most chronic, and is illustrated in this study by Cases 1, 2, and 6 (See Figs. 2, 5, and 16).

The second variety (infiltrating type) represents the more acute form of the disease, in which the attempt on the part of the marrow and surrounding bone elements to localize the disease is inefficient. Such a process, if allowed to progress, may involve the greater part of the shaft of a bone and result in a diffuse tuberculous diaphysitis. Case 4 is an illustration of this infiltrating type of disease (Fig. 10).

The third variety (atrophic type) is seen nearly always in the metaphyseal ends of long bones and is characterized by local atrophy of the bone lamellae, with little or no periosteal proliferation. The process

may extend to the articular cartilage, but does not, as a rule, invade it. Cases 3 and 5 are examples of this classification (Figs. 7 and 13).

In summing up the pathological picture, we may say that a tuberculous focus may originate in any portion of the shaft of a bone, and that its tendency is to form an abscess. The formation of this abscess causes a definite reaction on the part of surrounding bony structures, which in the diaphysis is much more marked than in the metaphysis. The fate of the bone abscess may be: (1) to remain encysted; (2) to spread unchecked along the marrow cavity; (3) to extend from the medulla to the periphery, later involving the surrounding soft parts; or (4) to extend from an original metaphyseal focus into the epiphysis and later into a joint.

The X-Ray Picture:

A study of the roentgenographic findings in these cases shows certain characteristics that are common to all of the lesions, such as their central origin, abscess formation, and lack of sequestrum formation. It is interesting to note, however, that the reaction of the surrounding bony tissues to the abscess varies considerably in different regions of the shaft. In the metaphyseal portion of the bone, illustrated by Cases 3 and 5 (Figs. 7 and 13), we find little or no reaction to the bone abscess, either on the part of the periosteum or of the adjacent bone lamellae; whereas, in the diaphyseal portion of the shaft, the periosteal and lamellar reaction about the tuberculous focus is very marked. Again, where the lesions are located in the metaphyses, there is no apparent expansion of the bone; while in the diaphysis local expansion of the shaft is one of the outstanding x-ray features of tuberculosis. This characteristic local expansion of the bone helps to differentiate the lesion from Brodie's abscess and from simple bone cyst, while giant-cell tumor may be ruled out on the basis of its rare occurrence in the mid-portion of long bones.

A study of the roentgenograms of Case 1 (Figs. 1 and 2) affords a clue concerning the development of tuberculous lesions in the mid-shaft of bones. In this case, successive x-rays were taken over a period of two years and the complete evolution of the tuberculous foci from their origin to their radical removal and cure by surgery can be observed. It will be seen that in the early stages (Fig. 1) there is a marked periosteal proliferation about the entire shaft of the ulna, most marked, however, at the two points where central disease of the bone is located. This x-ray appearance closely resembles syphilis, so closely, in fact, that the diagnosis of syphilis was made and maintained in this case until repeated negative Wassermann tests, plus the failure of antiluetic therapy, and a positive pathological diagnosis of tuberculosis excluded it.

As time went on, it is apparent that these central bone lesions became more clearly defined and walled off as distinct abscesses, and that, hand in hand with this development, the periosteal proliferation subsided and remained localized only at the sites of the two lesions. Following this

stage, lateral expansion of the shaft undoubtedly progressed, with a gradual thinning of the cortical layers, until the abscess perforated its bony shell and extended beyond into the soft tissues.

In Case 1, we are fortunate in seeing the disease in its earlier roentgenographic manifestations; in Cases 2, 4, and 6, we observe the tuberculous foci in the later stages, when they are about to perforate their bony shells or have already perforated them. We are not able to state with certainty what earlier examinations of these latter three cases would have shown, but it is not unlikely that the picture would have been very similar to that seen in Case 1, just described.

When we look at tuberculous lesions in the metaphysis of bone, as illustrated by Cases 3 and 5 (Figs. 7 and 13), we see an entirely different x-ray picture. Here we have little or no periosteal reaction, no proliferation of the bone lamellae, no expansion of the shaft, and no suggestion of sequestra.

Special attention should be called to the x-ray appearance of Case 4 (Fig. 10), which closely resembles chronic pyogenic osteomyelitis. The bone lesion in this case was complicated by a sinus, and secondary infection was present at the time of operation. This fact may have altered the x-ray picture considerably, but it is clearly evident that the tuberculous foci here did not become encysted, as is usually the case, but spread up and down the medullary canal, infiltrating the bone extensively as they progressed. Pathologically speaking, this represents the infiltrating type of tuberculous lesion in the shaft of bone, and the roentgenogram (Fig. 10) shows it beautifully.

In summing up, we may say that tuberculosis of the shaft of long bones shows various manifestations by x-ray that differ according to: (1) the stage of the disease, (2) the region of the shaft involved, and (3) the resistance and ability of the bone elements to wall off the invading tuberculous focus.

Treatment:

All of the cases in this series were treated by subperiosteal excision of the local lesions with careful and thorough removal of all suspicious tuberculous tissue. The operative wounds of all of the cases, except one, were sutured tightly without drainage. In Case 4, since there was a sinus with secondary infection at the time of operation, the wound was packed with sterile vaselin gauze postoperatively, and a plaster cast applied to the arm after the method of Orr. The wound was dressed every two weeks, and healed completely in seven months' time.

This subperiosteal-excision treatment resulted in complete cure of five out of the six cases in this series, as shown by sustained healing of the operative wounds and by subsequent roentgenographic examination of the affected bones. Case 6 has not been heard from since discharge from the Hospital and, therefore, the end result in this case cannot be recorded.

SUMMARY

Six cases of tuberculosis of the shaft of bone in Chinese patients are reported with a discussion of the clinical, pathological, and roentgenographic characteristics.

Treatment of the disease by subperiosteal excision of the bone abscesses resulted in complete cure in all of the cases, except in one in which no end result was obtained.

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OBSERVATIONS ON TORSION OF THE FEMUR *

BY S. PERRY ROGERS, M.D., SAN JUAN, PORTO RICO
Virgil P. Gibney Memorial Fellow at the Hospital for Ruptured and Crippled, New York City

In a previous publication [5] the author described a simple but accurate method for determining the angle of torsion of the neck of the femur by fluoroscopic examination. A prior publication, unknown to the author at that time, had been made by Stewart and Karshner [6], describing a method similar in principle though not so simple in operation, and applied by them only to cases of congenital dislocation of the hip.

This report is based upon examinations, by the author's method, of a large group of normal children and of a smaller group affected by disease or deformity of one or both lower extremities.

Briefly, the technique of examination is as follows: The subject is placed face downward on the fluoroscopic table and the tube centered beneath the hip. The extremities are moderately abducted and the leg is flexed ninety degrees. With the tube lighted, the femur is externally rotated by pushing the flexed leg toward the opposite knee until the shadow of the head and neck of the femur appear in a line with the shaft. The angle between the flexed leg and the table then equals the angle of torsion of the neck. The author uses as a goniometer a two-foot, folding carpenter's rule with a perimeter in the central joint. The method has been proven accurate within five degrees and applicable to any hip, in joint or out, which allows of a moderate degree of rotation and which has a head and neck roentgenographically visible.

NORMAL FEMORA

Both hips were examined in ninety-nine children with presumably normal lower extremities. Nine anatomical specimens obtained from foetuses and infants below the age of calcification of the capital epiphysis were measured by the method of Pearson and Bell [4]. The results are shown in Table I and Graph 1. They show an average individual variation in each age group of twenty-two degrees and a variation in the entire series of seventy-five degrees. In no normal individual, however, was there a variation of more than six degrees on the two sides. No important difference in the sexes was demonstrable. The most striking feature shown is the rapid increase in torsion up to the age at which weight-bearing commences, and its gradual decrease from then until puberty, when it levels off at about the degree recognized as normal for adults.

ABNORMAL FEMORA

Twenty-nine cases of unilateral abnormality and six cases of bilateral

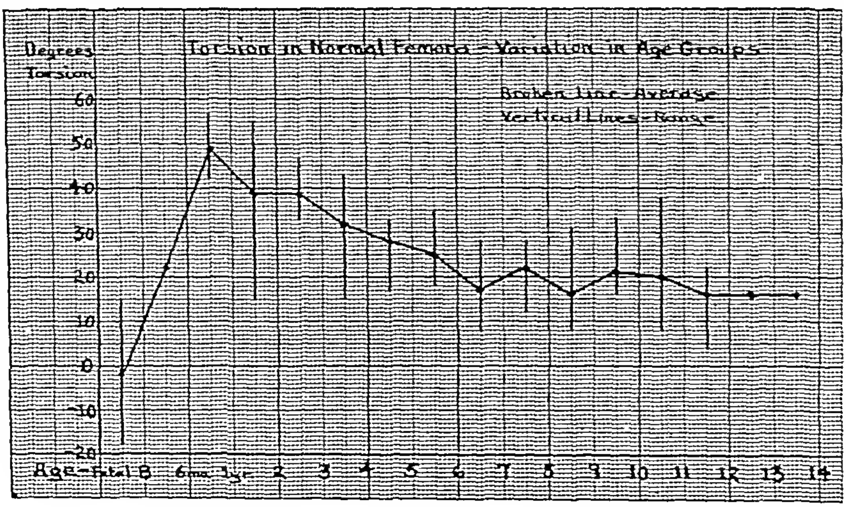
* Received for publication July 23, 1933.

TABLE I

Torsion in Normal Femora—106 Cases

Age	No. of Cases	Range (*Degrees*)	Average (*Degrees*)
Foetal	5	−18 to 15	−2
Birth–6 months	1		22
6 months–1 year	2	42 to 57	49
1–2 years	7	15 to 55	39
2–3 years	3	33 to 47	39
3–4 years	6	15 to 43	27
4–5 years	4	17 to 33	28
5–6 years	7	18 to 35	25
6–7 years	5	8 to 28	17
7–8 years	10	12 to 28	22
8–9 years	17	8 to 31	17
9–10 years	8	16 to 33	21
10–11 years	13	8 to 38	20
11–12 years	16	4 to 22	16
12–13 years	1		16
13–14 years	1		16

abnormality are presented in Table II. They are arranged by age and not by diagnosis, in order to show the normal age variation in the unaffected extremities and because the cause of disability apparently does not matter. With one exception (J. T., aged six years, five months) they show that any



Graph 1

TABLE II-A

Torsion in Unilateral Abnormalities

Name	Age Years	Age Months	Diagnosis	Torsion (Degrees) Normal	Torsion (Degrees) Affected
R. H.	1	0	Poliomyelitis, right lower extremity, 3 months' duration.	30	45
J. M.	1	5	Osteomyelitis, left femur, ? duration.	44	54
N. S.	1	6	Congenital dislocation of left hip.	50	64
B. K.	1	9	Congenital dislocation of left hip.	50	62
R. D.	1	10	Congenital dislocation of left hip.	43	60
I. K.	2	5	Poliomyelitis, left lower extremity, 15 months' duration.	23	44
V. T.	2	6	Poliomyelitis, left lower extremity, 19 months' duration.	20	55
G. W.	3	2	Congenital dislocation of right hip.	45	52
R. G.	3	5	Poliomyelitis, right lower extremity, 16 months' duration.	34	47
M. R.	3	5	Poliomyelitis, left lower extremity, 15 months' duration.	14	28
E. S.	3	6	Congenital dislocation of left hip.	20	50
M. D.	3	6	Poliomyelitis, right lower extremity, 19 months' duration.	48	60
B. B.	4		Healed fracture of right femur.	42	35
C. F.	4	5	Poliomyelitis, right lower extremity, 26 months' duration.	22	40
P. G.	4	6	Congenital dislocation of right hip, open correction 10 weeks before.	30	40
G. C.	5	10	Old infection of right hip, pneumonia at 9 months.	7	60
J. H.	6		Furunculosis, right lower extremity, ? duration.	28	38
M. B.	6		Old cervical fracture, neck of right femur.	30	17
J. T.	6	5	Osteomyelitis, left tibia, 5 months' duration.	18	13
S. F.	6	11	Poliomyelitis, left lower extremity, 16 months' duration.	18	36
W. S.	7		Osteomyelitis, right femur, ? duration.	15	20
H. L.	7	10	Poliomyelitis, right lower extremity, 19 months' duration.	30	40
E. M.	8		Coxa vara, unknown etiology.	25	10
J. G.	8	4	Osteomyelitis, right tibia, 8 months' duration.	20	42
J. F.	9	10	Osteomyelitis, right tibia, 2½ months' duration.	20	38
H. F.	9	10	Suppurative arthritis, left knee, 7 years' duration.	32	66
D. M.	11	0	Brodie's abscess, right tibia.	15	25
S. F.	11	4	Slipped femoral epiphysis, right.	22	5
N. Y.	13	1	Osteomyelitis, right tibia, 2 years' duration.	18	34

TABLE II-B

Torsion in Bilateral Abnormalities

Name	Age Years	Age Months	Diagnosis	Torsion (Degrees) Left	Torsion (Degrees) Right
D. B.	1	8	Congenital dislocation both hips.	85	85
J. D.	2	0	Double club foot, walking 1 month.	30	30
A. C.	5		Poliomyelitis, both lower extremities, 15 months' duration.	48	48
G. M.	9	7	Congenital dislocation both hips.	50	50
M. G.	13	6	Bilateral slipped femoral epiphyses.	0	−15

disability causing cessation or diminution of function in a growing extremity is accompanied by an increase in torsion of the femur. In slipped epiphyses the dislocation of the head backward produces what amounts to a retroversion, or decrease in torsion, in so far as the extremity is concerned. The case of old cervical fracture shows the same retroversion. The case of healed fracture of the shaft simply demonstrates a slight rotatory deformity in a fracture in which position and alignment were considered excellent.

NATURE OF TORSION

The terms "torsion of the neck" and "anteversion of the neck" are misnomers. The greater part of the twisting occurs below the neck, and

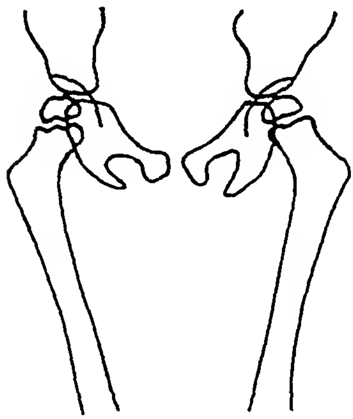


FIG. 1

Tracing of roentgenogram, showing true postero-anterior views of both necks with torsion eliminated.

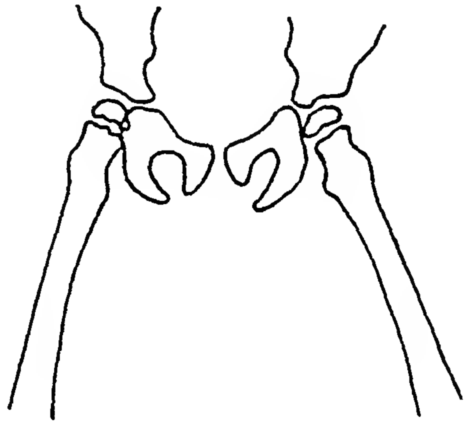


FIG. 2

Tracing of roentgenogram, showing true lateral views of both necks with torsion eliminated.

is probably distributed throughout the shaft. Roentgenograms taken with torsion corrected demonstrate this. Figure 1 shows what the author chooses to call a true postero-anterior view of both necks, made by internally rotating each femur the number of degrees previously determined as its torsion. Figure 2 shows a true lateral view of both necks, similar to a "vertical projection", but made in this case by rotating each femur outward ninety degrees from the positions used in Figure 1. Such roentgenograms, taken of hips with an actual difference of as much as sixty degrees in torsion on the two sides, show the outlines of head and neck and the positions of the trochanters practically identical.

RELATION OF TORSION TO INCLINATION

No term has ever been used more loosely than "coxa valga". The routine roentgenogram made with patellae forward and without regard to torsion, frequently shows an increased angulation of the neck with the shaft, the greater part of which is usually due to torsion. The illustra-

tions accompanying the recent study of the muscular involvement in paralytic dislocation of the hip by Elzinga and Key [1] show several extreme cases of torsion, identical with paralytic cases in this series, labeled simply coxa valga. The term can be correctly used to designate this condition only if it is clearly realized that it includes changes in both torsion and inclination, of which the former are the more important.

The actual angle of inclination of the neck with the shaft of the femur can be measured in the living subject by means of x-rays taken with torsion eliminated, as in Figure 1. Such measurements were made in a small series as a part of this study. They showed actual increases in deviation of seven to twelve degrees regularly accompanying increases in torsion of fifteen to forty-five degrees. Increases in inclination are always moderate, while increases in torsion may be extreme; so that the more extreme the coxa valga apparent in the ordinary roentgenogram, the greater is the proportion of this appearance due to torsion. Concomitant increase in both angles is the rule. Occasionally a case of long-standing dislocation of the hip is met with, in which extreme anteversion is accompanied by actual decrease in inclination. Ordinary x-rays in these cases still show "coxa valga".

INTERPRETATION OF RESULTS

Explanation of the variability of torsion of the femur in different species of vertebrates, in different races of man, and in succeeding age groups of man, is difficult. The exhaustive studies of Pearson and Bell [4] show slightly greater torsion in the more civilized races of man, but offer no real anthropological clue. The small group of foetal anatomical specimens included here indicate that the high torsion in the year-old infant is not a heritage from prenatal life.

The author's studies demonstrate, first, that bone is a living tissue, responsive to the stimulus of function. An increase of eighteen degrees in the torsion of a femur, two and one-half months after the onset of an osteomyelitis of the lower end of the tibia, shows that this response may be rapid. In general, the longer the duration of the disability and the younger the individual at its onset, the greater will be the increase in torsion.

The character of the response of the femur to the stimulus of function is clear. The age variation and the behavior under functional stresses both indicate that torsion and inclination are inversely proportional to function. The reason for such change is not so clear. Increase in inclination with cessation of weight-bearing is easy to understand, but as to why torsion increases even more rapidly under these circumstances the author has no explanation.

Torsion has received serious consideration in relation to congenital dislocation of the hip. Fairbank [2] stressed the importance of anteversion in his anatomical studies, and the important references on the subject are

listed by him. Krida[3] and others perform osteoclases or osteotomies after reduction in many cases. As to etiology, the author's figures would indicate that anteversion is the result and not the cause of dislocation, and that the cause is that common to other instances of anteversion,—loss of function. Several cases of moderate anteversion have been followed after reduction and seen to approach the torsion of the opposite femur when walking was resumed. In judging the severity of the anteversion in a dislocated hip, it is well to consider the normal age ratio, and better still to measure the torsion on both sides.

In slipped femoral epiphyses the dislocation is backward and downward, usually more backward than downward. The effect is that of reduction of both torsion and inclination, except that the shift occurs at one point instead of being distributed. The cause is increase in function, beyond the strength of the part. Thus the conditions form an interesting corollary to the hypothesis that increased inclination and torsion are due to diminished function. At any rate, this much may be granted,—that the increase in torsion and inclination consequent upon rest is an important factor in the improvement of these cases under any sort of treatment.

One more use has been found for the accurate determination of torsion and inclination. In attempting to drill the neck of the femur without complete surgical exposure, an accurate knowledge of the angles in the particular femur involved is much more valuable than simply a knowledge of the average normal angles in adults. In slipped epiphyses, Perthes' disease, united fractures of the neck, etc., the author's method is applicable, of course, only where continuity of the parts will permit the manipulations necessary for the examination.

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TREATMENT OF OSGOOD-SCHLATTER DISEASE WITH DRILL CHANNELS *

BY E. J. BOZSAN, M.D., AND THOMAS J. O'KANE, M.D.,
NEW YORK, N. Y.

From the Division of Skeletal Surgery, Morrisania City Hospital, New York

It is well known that a large majority of cases of Osgood-Schlatter disease either require no treatment whatever or respond favorably to conservative measures. However, the opinion is expressed frequently that there is a certain, if very small, percentage of cases that call for some form of operative treatment. Operations ranging from the simple bone-splitting incision[1] to bone grafting[2] and removal of the diseased areas[3] have been devised.

The present-day conception of the disease, as it has become differentiated since the original publications of Osgood[4] and Schlatter[5], separates the traumatic avulsion of the tibial tubercle and the cases of bone formation in the patella tendon, later described, from this distinctly chronic process.

Irrespective of the etiological relationship of the two groups, we are at this time concerned only with the chronic cases, not manifestly traumatic, which correspond to those described by Schlatter and those classified as Group 2 in the description of Osgood.

Following the line of thought that prompted one of us to recommend drill channels for treatment of the Legg-Calvé-Perthes disease and of intracapsular fractures of the neck of the femur[6], we have applied this simple procedure to cases of Osgood-Schlatter disease, with the expectation that the fresh blood supply conducted to the diseased areas of bone would improve the condition,—that is, facilitate and so hasten the process of natural repair.

The technique is simple. A small incision or stab wound is made over the affected tibial tubercle and one or two channels are drilled through the diseased area, indicated on the roentgenogram, into the cancellous upper end of the tibia. Immobilization in plaster-of-Paris seems unnecessary. Patients are allowed to walk as soon as they are able to do so without pain.

During the year 1932, six cases have been treated in this manner with gratifyingly prompt results. The clinical symptoms have subsided within three or four weeks and complete bony restoration has been demonstrable by x-ray examination as early as seven weeks after operation. During this time pain and swelling have disappeared; the patients have regained their confidence in the extremity; and have been able to bear weight in a squatting position.

* Read before the Clinical Society of the Hospital for Joint Diseases, New York February 7, 1933.

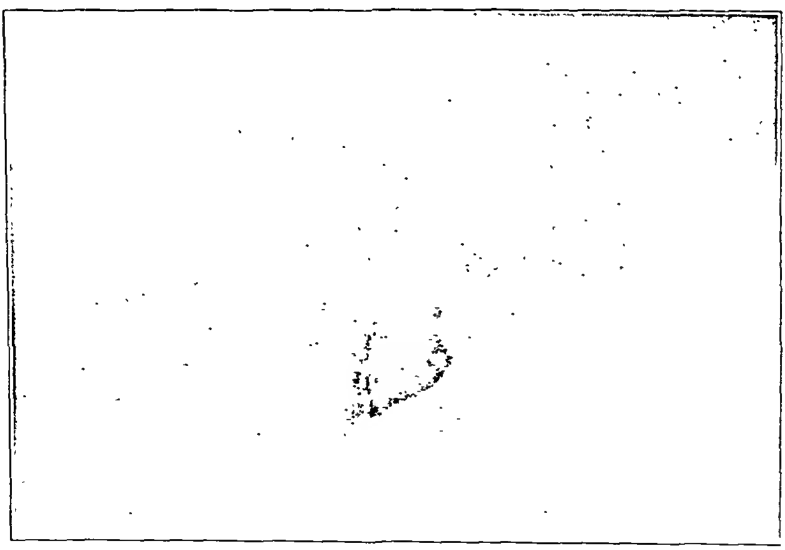

FIG. 1

Case 1. Roentgenogram taken January 14, 1932. Tibial tubercle partially absorbed and fragmented.

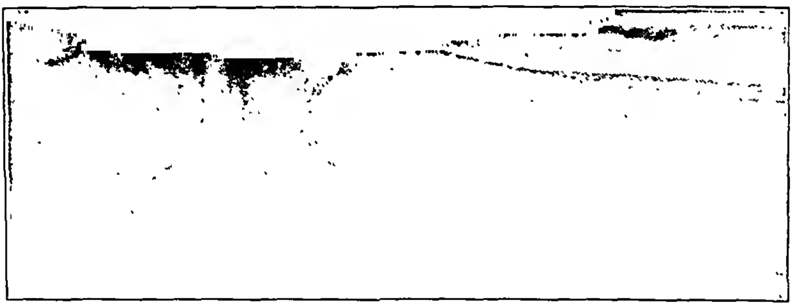

FIG. 2

Case 1. Roentgenogram taken May 7, 1932, fourteen weeks after operation. Tibial tubercle completely restored.

FIG. 3

Case 1. Roentgenogram taken July 5, 1932. Complete restoration and fusion of tip of tubercle.

CASE HISTORIES

Case 1 (Figs. 1, 2, and 3). B. S., girl, eleven years of age (No. 29529), was admitted to the hospital January 13, 1932. Symptoms of pain and tenderness had been present for six months. Roentgenogram taken the following day (Fig. 1) revealed the tubercle fragmented and considerably absorbed. Drilling operation was performed on February 1, 1932. On withdrawal of the drill, a large drop of mucilaginous material issued out of the hole under some pressure. Cultures of this and bone chips were negative. Due to the fact that this patient had to be placed in a plaster spica on account of a coexisting process in the hip joint, the earliest postoperative roentgenogram could not be taken until May 7, 1932 (Fig. 2). This indicated complete restoration of the tibial tubercle, and a follow-up picture July 5, 1932, (Fig. 3) showed tip fused with main body of the tibia.

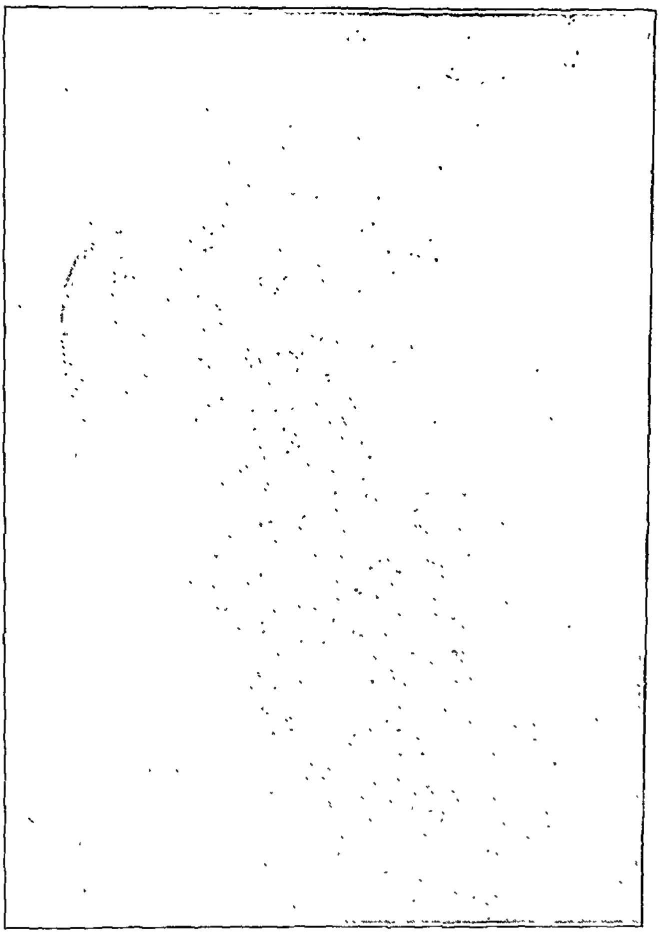

Fig. 4

Case 2. Roentgenogram taken December 7, 1931. Tibial tubercle fragmented and tip absorbed.

Case 2 (Figs. 4, 5, 6, and 7). E. Q., boy, aged fifteen years (No. 28026), had been treated in the Out-Patient Department since the fall of 1931. Symptoms had been present with varying intensity for the last fourteen months. Roentgenogram December 7, 1931, (Fig. 4) showed the tubercle fragmented and its tip absorbed. Patient refused operation but returned in the spring of 1932 on account of exacerbation of symptoms. X-ray (Fig. 5) April 26, 1932, revealed identical condition as four and one-half months before. Drilling operation was done on May 6, 1932, and the limb immobilized for two weeks. Patient was discharged May 30, 1932. When he reported to the clinic about eight weeks after operation, July 1, 1932, the roentgenogram (Fig. 6) revealed the previously absorbed tip of the tibial tubercle restored. All clinical symptoms were absent and the patient had full use of the limb. He did not report again until March 20, 1933, on which occasion the x-ray (Fig. 7) revealed complete restoration of the tibial tubercle and union of the small fragments with the main body of the tubercle, with only a small hiatus indicating the upper border of the small fragment. He was completely free of symptoms.

Case 3 (Figs. 8, 9, 10, and 11). J. R., boy, fourteen years old (No. 31847). Symptoms had been present for five months previous to admission. X-ray September 8, 1932, revealed the tip of the right tibial tubercle absorbed. Operation was performed September 19, 1932, and patient was discharged two days after operation with plaster-of-Paris bandage which he wore for a period of two weeks. About eight weeks after operation

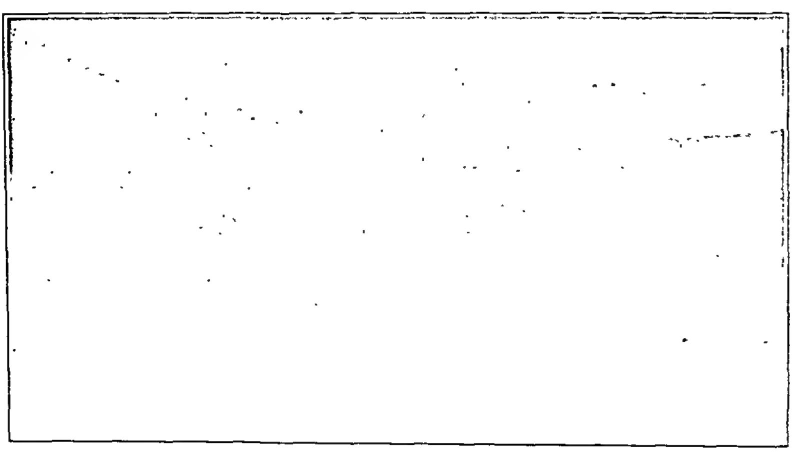

FIG. 5

Case 2. Roentgenogram taken April 26, 1932. Condition unchanged.

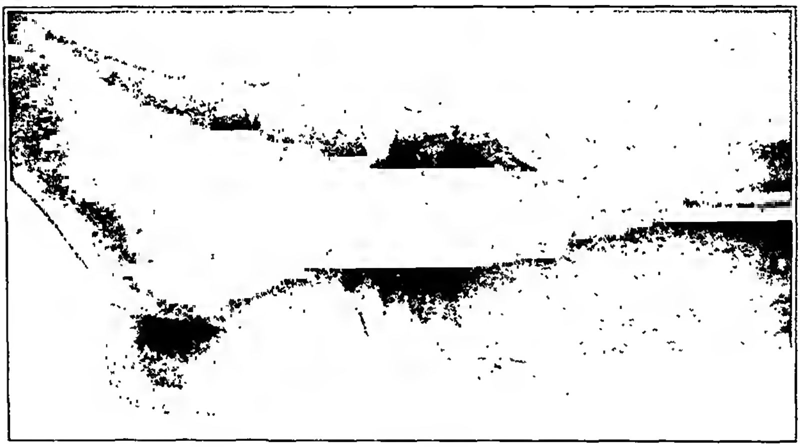

FIG. 6

Case 2. Roentgenogram taken July 1, 1932, eight weeks after operation. Tip of tubercle restored.

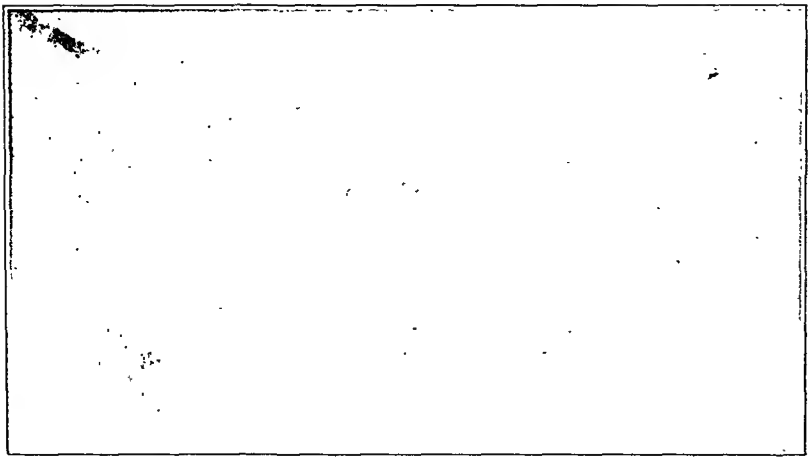

FIG. 7

Case 2. Roentgenogram taken March 20, 1933. Almost complete restoration of tibial tubercle.

Fig. 8

Case 3. Roentgenogram taken September 8, 1932. Tip of tubercle absorbed.

Fig. 9

Case 3. Roentgenogram taken November 1, 1932, six weeks after operation. New bone formation beginning.

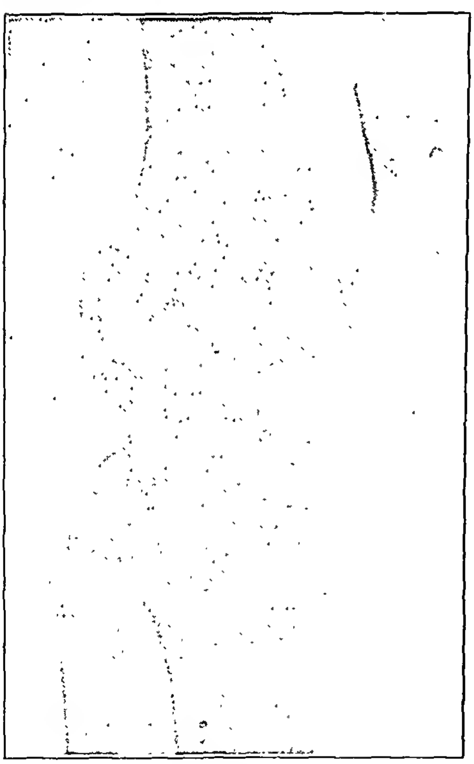

Fig. 10

Case 3. Roentgenogram taken December 3, 1932. Complete restoration.

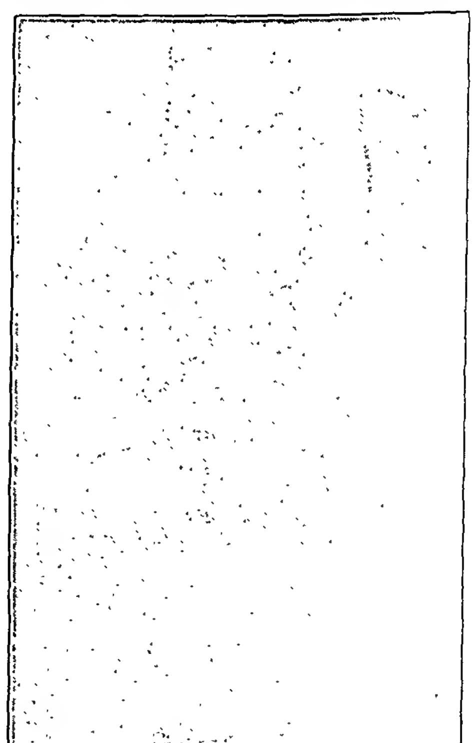

Fig. 11

Case 3. Roentgenogram taken January 12, 1933. Complete restoration, firm union.

FIG. 12

Case 4. Roentgenogram taken October 14, 1932. Fragmentation and absorption of the tubercle.

FIG. 13

Case 4. Roentgenogram taken December 1, 1932, seven weeks after operation. Complete restoration.

FIG. 14

Case 5. Roentgenogram taken December 10, 1932. Tubercle fragmented and considerably absorbed.

FIG. 15

Case 5. Roentgenogram taken February 25, 1933, ten weeks after operation. Fragments united. Size of tubercle considerably increased.

Fig. 16

Case 6. Roentgenogram taken December 10, 1932. Tubercle fragmented and rarefied.

Fig. 17

Case 6. Roentgenogram taken February 25, 1933, ten weeks after operation. Fragments united and size of tibial tubercle considerably increased.

the boy was entirely free from clinical symptoms. Roentgenogram November 1, 1932 (Fig. 9) revealed bone formation at the site of the previously absorbed tip and apposition of new bone over the body of the tubercle. X-ray on December 3, 1932 (Fig. 10) showed tibial tubercle totally restored, as did another (Fig. 11) taken January 12, 1933.

Case 4 (Figs. 12 and 13). W. P., boy, thirteen years of age (No. 32670), had had symptoms for eight months. Roentgenogram (Fig. 12) taken on October 14, 1932 revealed fragmentation and absorption of right tibial tubercle. Operation was done on October 15, 1932, and patient was discharged October 17, 1932, without application of plaster-of-Paris. On December 1, 1932, patient was free of all symptoms, and an x-ray (Fig. 13) at this time, seven weeks after operation, revealed complete bony restoration of the tibial tubercle.

Case 5 (Figs. 14 and 15). J. S., boy, fifteen years old (No. 34838). Symptoms had been present on both sides for eight months. X-ray (Fig. 14) December 10, 1932, revealed diffuse absorption of the right tibial tubercle and a fracture at its base. Operation was performed on December 19, 1932, and patient was discharged December 21, 1932, without any immobilization. On February 25, 1933, the patient was free of symptoms, and roentgenogram (Fig. 15) taken at this time revealed bony formation, increasing the size of the tibial tubercle, and union of fracture line.

Case 6 (Figs. 16 and 17). Same patient as Case 5. X-ray (Fig. 16) December 10, 1932, revealed left tibial tubercle fragmented. Operation was done the same day as that on the right side. When seen on February 25, 1933, the patient was free of symptoms. Roentgenogram at this time (Fig. 17) revealed considerable restoration of the outline of the tibial tubercle and disappearance of the fragment.

It is difficult to decide when to consider conservative measures inadequate. The intensity of symptoms, the ensuing disability, and the

period of recovery vary so widely that it seems futile to try to establish an average picture of the disease. Schlatter's observation that the older the child, the better are the chances of spontaneous recovery is of little help in the great number of cases between the ages of eleven and fourteen.

Osgood speaks of "severe handicap and long continued serious annoyance", Schlatter of "recurrent attacks of pain over a long period of time". Campbell[7] mentions instances in which one or more years elapse before the symptoms entirely subside.

We wish to emphasize that these are the cases, and these only, for which this simple operative procedure is recommended.

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THE EFFECTS OF IMMOBILIZATION ON NORMAL BONE

BY FRANCIS M. CONWAY, M.D., AND JOHN G. STUBENBORD, 3D, M.D.,
DOUGLASTON, NEW YORK

At the present time there is, at best, a vague knowledge concerning the effect of immobilization on the growth of healthy, uninjured bone. According to Wolff's law, "All changes in the function of a bone are attended by definite alteration in their internal structure", one would expect atrophy of the part through disuse.

As we thought over the problem the following question presented itself: Would normal, healthy, uninjured bone show signs of atrophy of disuse as demonstrated in a roentgenogram?

Method

Because of convenience we selected the wrist. Immobilization of the wrist and the forearm was accomplished by the use of plaster-of-Paris splints. Anterior and posterior splints were used and were held in place with a bandage. Immobilization of the knee joint was carried out in one case by a posterior plaster-of-Paris splint.

We tried to immobilize the wrist for two weeks; for, during a corresponding length of time, marked atrophic changes are seen in the roentgenograms of a fractured bone following injury. As this period was not possible in all the cases, however, the length of immobilization ranged from seven to twenty-four days.

Roentgenograms were taken of both the right and left wrists and forearms for comparison; anterior, posterior, and lateral views were taken. Splints were applied to the left wrist only. After the period of immobilization the splints were removed and roentgenograms were again taken of both wrists. The plates were read and compared with the corresponding plates previously taken.

Report of Cases

The following factors were considered of importance as influencing the anatomy and histology of bone,—namely, sex, age, general physical habitus, occupation of patient.

Our findings in the twelve cases considered are shown in Table I.

Results

The late Dr. Webster W. Belden, Director of the Roentgenology Department, New York Hospital, who was interested in this problem and who read the plates, stated that, "The x-ray film showed no evidence of bony changes".

This is entirely different from the changes which take place in bone, in the presence of injury, as seen by roentgenograms, within a period of ten to fourteen days. The process causing these changes is called "osteoporosis" and is caused by the absorption of the lime salts. From a roentgenographic standpoint these changes are in evidence as:

1. Decrease in the density of the bone,
2. Thinning of the cortex of the bone,
3. Apparent widening of the medullary canal.

The reason for the decalcification of the bone is not thoroughly understood, but is believed to be due to a change in the metabolism of the bone resulting from the injury, because of interference with the circulation.

Comment

1. The selection of the cases was difficult and in part accounts for the small number observed. Because of the rapid turnover on our Surgical Service, few patients are kept in the hospital over two weeks. Thus the number of available patients, from whom we could select our cases, was greatly limited. Moreover, we did not feel justified in adding another hardship to the already sick, but convalescent, patient in an abdominal surgical case.

Patients suffering from general constitutional diseases were unsuitable. In cachectic diseases in which there is anaemia, as in carcinoma, in pernicious anaemia, or in general chronic constitutional diseases, such as tuberculosis, atrophic changes through disuse can be identified by x-ray after a short period. The changes are less marked in degree than those found in injured bone, but they are generalized, involving all the bones; whereas, in an injured bone the atrophy through disuse in the presence of injury is local, but quite marked.

This meant that only healthy patients were suitable cases. There were two distinct classes: those who were compelled to stay in the hospital through accidental injury, and those who had some definite complaint of short duration but whose general health was excellent.

2. There was no control over the diet. The postoperative routine schedule was followed in all cases. No regulation of milk intake was observed.

3. The blood-calcium content was not investigated, because blood-calcium determinations alone are of little value and are not an index of the calcium metabolism and changes taking place in bones. The blood-calcium level is constant except in thyroid or parathyroid disease, in which conditions calcium is excreted above normal, and cases of this character have been excluded from this series. One would not expect calcium changes in fractured bones, due to the fact that the blood-calcium level remains constant. There may be a predisposition to decalcification of bone, or it may be the result of disease.

TABLE I

FINDINGS IN TWELVE CASES

Case	Sex	Age	Physical Frame	Occupation	Part Immobilized	Length of Immobilization	X-Ray Readings: Pre-Immobilization	X-Ray Readings: Post-Immobilization
1.	F	40	Medium	Housewife	Wrist, left	7 days	Bones of wrist seem normal.	After removal of the plaster-of-Paris cast, the bones of the wrist and hand show no change. No osteoporosis; if anything, there is a slight increase in calcification. This, however, probably due to varying density in film.
2.	M	30	Medium	Brakeman	Wrist, left	8 days	The detail of bones of both wrists seems quite normal. No evidence of injury or disease, nor any sign of osteoporosis.	Films done after removal of plaster-of-Paris cast show perfect detail of bone and no evidence of osteoporosis or other changes.
3.	F	38	Medium	Cook	Wrist, left	9 days	No variation from normal in either wrist joint.	No changes noted in bone.
4.	F	44	Obese, large	Superintendent	Wrist, left	11 days	Bones of wrist seem normal.	The radius, ulna, and carpal and metacarpal bones show no evidence of osteoporosis, indicating that the simple splinting of the joint does not cause bone atrophy.
5.	M	32	Thin, wiry	Carpenter	Wrist, left	13 days	Wrist joints show no signs of fracture.	Absolutely no change in the texture or calcium content of the bones of the radius, carpus, or metacarpus. No osteoporosis present.

Case	Sex	Age	Physical Frame	Occupation	Part Immobilized	Length of Immobilization	X-Ray Readings: Pre-Immobilization	X-Ray Readings: Post-Immobilization
6.	F	30	Medium	Housewife	Wrist, left	15 days	Bones of wrists and hand show no variation from normal. Calcium content of bone apparently normal.	No evidence of osteoporosis or disease of bones. Calcium content of radius, ulna, and carpal and metacarpal bones normal.
7.	M	34	Medium	Tailor	Wrist, left	15 days	The bone detail of both wrists, carpal bones, radius, and ulna shows normal appearance.	No evidence of bony changes seen.
8.	M	40	Medium	Kitchen helper	Wrist, left	16 days	No evidence of disease of bones.	No evidence of fracture or dislocation of lower ends of either forearm or wrist.
9.	M	28	Medium	Driver	Wrist, left	17 days	The bones of the forearm, wrist, and hand seem normal.	No definite evidence of bone changes seen.
10.	M	19	Slight, wiry	Chauffeur	Wrist, left	18 days	The detail of bones of both wrists seems quite normal, without any evidence of injury or disease, or signs of arthritic changes.	The bones are of normal texture and there is no evidence of abnormal calcium content.
11.	M	61	Medium with slight loss of tissue	Watchman	Knee, left	19 days		Comparing with the previous film one sees no difference in the bony detail. No signs of osteoporosis.
12.	M	24	Large	Butcher	Wrist, left	24 days	The texture of bones of both wrists seems quite normal. No sign of injury or disease.	Bones of the forearm and wrist show no evidence of change from the normal. No osteoporosis or evidence of injury.

4. Unsuitable cases were those of:

   1. Asthma
   2. Bone diseases
      Osteitis fibrosa cystica
      Osteitis deformans
      Osteomalacia
      Osteomyelitis
      Bone cysts
      Giant-cell tumor
   3. Chronic constitutional diseases
      Carcinoma
      Chronic suppurative processes exclusive of bony sites
      Pernicious anaemia
      Sickle-cell anaemia
      Tuberculosis
   4. Diseases in which there are circulatory disturbances
      Buerger's disease or endarteritis obliterans
      Diabetes
      Raynaud's disease
   5. Chronic hyperthyroidism (Aub)
   6. Parathyroid disease
   7. Pregnancy.

5. We tried to minimize variables associated with the taking of the roentgenograms, and the same machine was used, when possible. The voltage, spark gap, time exposure, were all constant. The distance between the part and the tube was measured exactly for each film and the same technician took all the films.

Conclusion

In the absence of injury, there are no signs of atrophy in normal, healthy bones through disuse *per se* during a period ranging up to three weeks, so far as may be observed from the roentgenograms.

The authors wish to acknowledge the suggestions and advice given by Dr. Nelson W. Cornell in the preparation of this report.

FURTHER OBSERVATIONS ON THE ABDUCTION-TRACTION TREATMENT OF CONGENITAL DISLOCATION OF THE HIP*

BY G. KENNETH COONSE, M.D., BOSTON, MASSACHUSETTS
AND WILLIAM J. STEWART, M.D., COLUMBIA, MISSOURI

From the Department of Orthopaedics, Crippled Children's Service, University Hospitals Columbia, Missouri

Prof. Vittorio Putti's original article [1] on the early treatment of congenital dislocation of the hip by gradual abduction with a portable splint was first published in October 1929. In July 1931, a simple modification of Putti's splint, combining traction with abduction, was reported by one of us (G. K. C.)[2]. Since this time some minor improvements have been made in the splint. Seven cases have been followed over a period of three and one-half years, and in three additional cases the patients are just starting treatment with the splint. Several of these patients are now discharged from active treatment, and a sufficient period of time has elapsed to get a rather good estimate of the end results to be expected from this type of treatment.

It is the purpose of this paper to publish the results of these cases, with a discussion of the advantages and limitations of the method as they have appeared to date.

The procedure that we have followed in using the splint has been to abduct the hip gradually on the splint until full abduction or even hyperabduction is accomplished, and until the hip is reduced. In most cases,

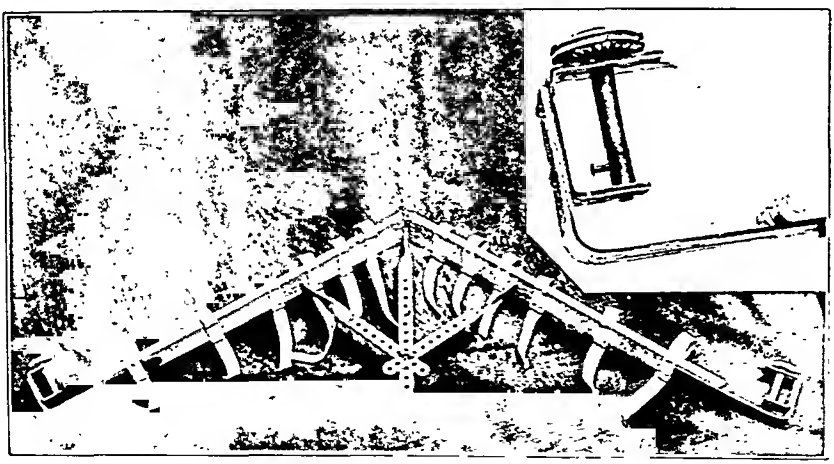

Fig. 1

Improved splint now in use, with ratchet control of traction.

* Received for publication August 14, 1933.

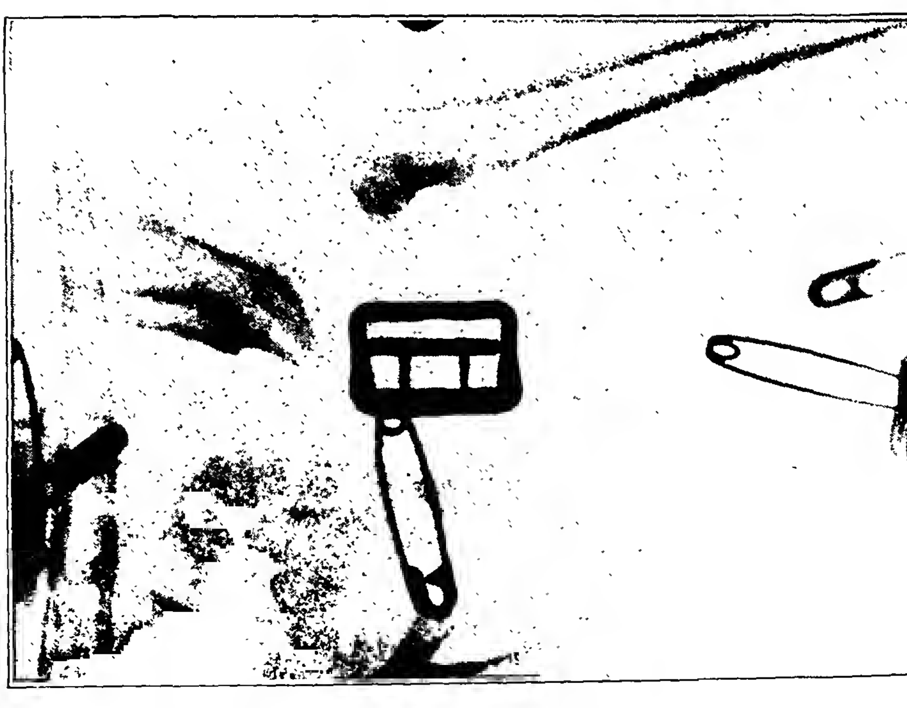

FIG. 2

V. T., Feb. 1, 1930. Beginning of treatment. No traction used in this case. The splint has been applied one week.

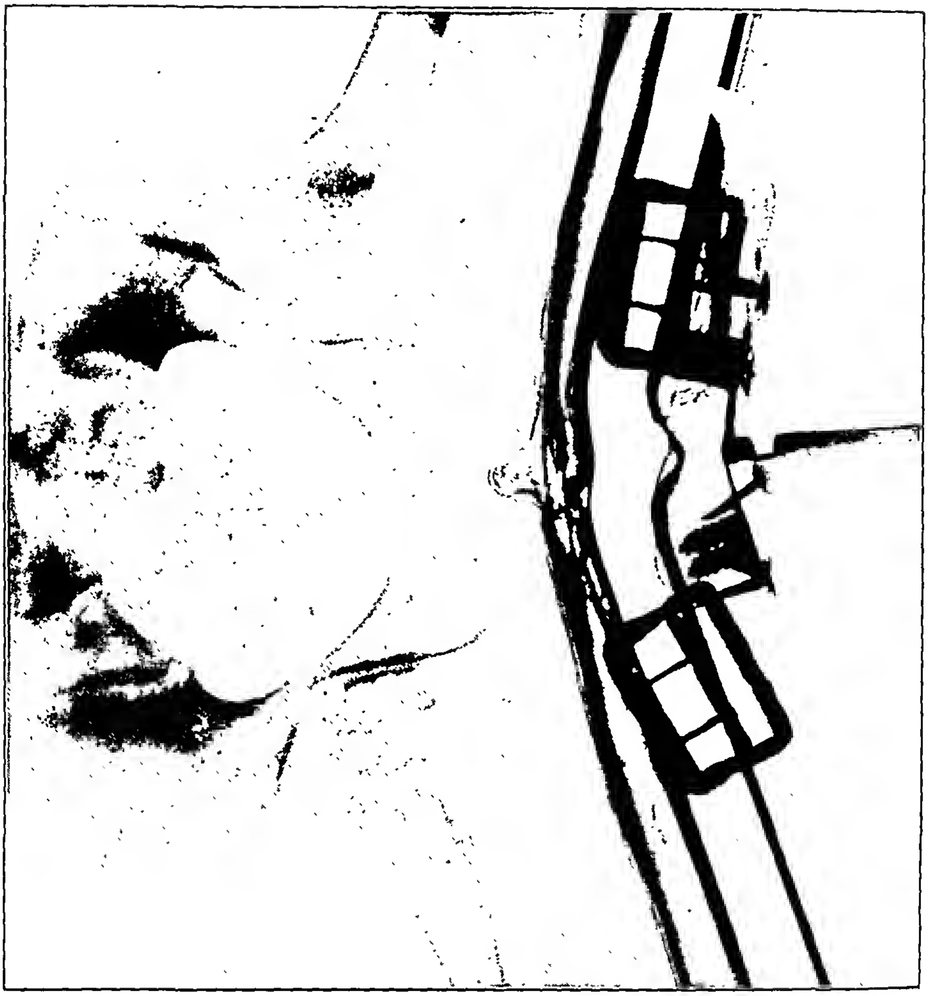

FIG. 3

V. T., Aug. 6, 1930. Spontaneous reduction. No skin traction used. Position of wide abduction.

FIG. 4

V. T., Feb. 18, 1931. Splint removed. Weight-bearing started.

FIG. 5

V. T., June 17, 1931. End result.

Fig. 6
V. B., Nov. 10, 1930. Before treatment.

Fig. 7
V. B., March 23, 1931. Spontaneous reduction. Skin traction of eight pounds was applied.

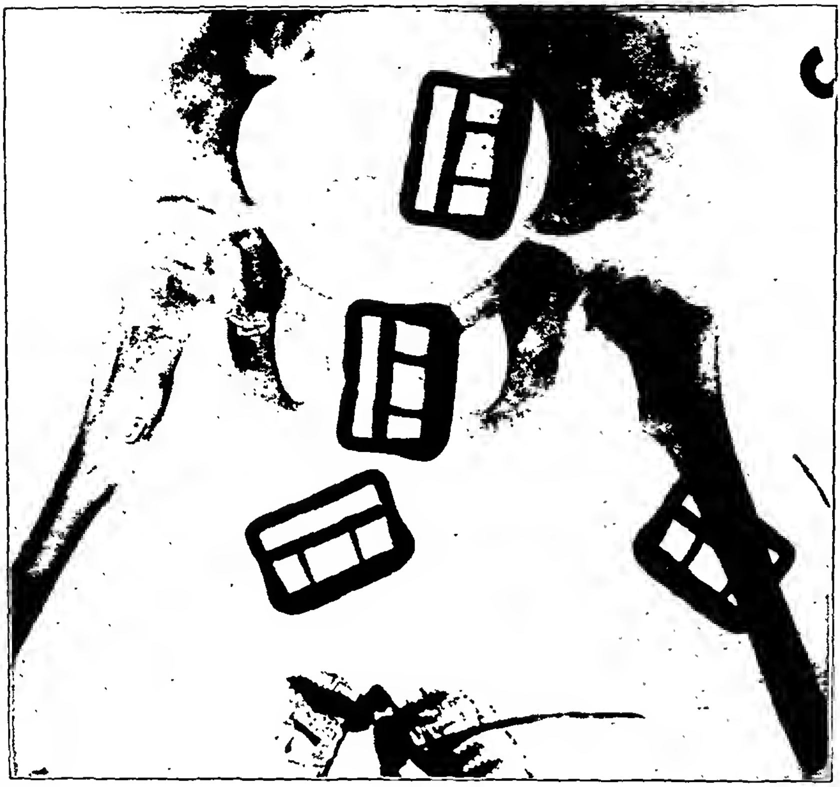

FIG. 8
V. B., June 29, 1932. Splint removed. Well formed head, deep acetabulum.

the head of the femur will drop readily into the acetabulum by the time the abduction has been completed. The reduction may be accomplished in a week or may take as long as six months, depending upon the individual case. The hips are left in the reduced hyperabducted position for approximately twelve weeks before bringing them down to a straight position. This is done by dropping the splint a notch at a time, taking essentially the same length of time that it would take to abduct the legs, or even longer. Traction is used during the stage of abduction and is discontinued as soon as reduction has taken place.

Occasionally, because of the extreme rotation of the head and neck of the femur, it will be necessary to do a closed reduction after abduction has been completed. This is exceedingly easy to do, as it is necessary only to get the patient anaesthetized and to gently roll the head of the femur into the acetabulum and maintain it in this position by plaster immobilization.

Cases seen in early infancy present no particular problem, but in the later cases, where contractures of the soft parts have occurred, most of the difficulties common to any type of treatment have been encountered. Gradual abduction of the thighs will bring about relaxation of the con-

FIG. 9
P. L., Jan. 14, 1932. Before treatment.

FIG. 10
P. L., Sept. 23, 1932. Splint removed. Hips stable. No weight-bearing.

TABLE I

TABULATED DATA ON ABDUCTION-TRACTION SPLINT TREATMENT

Name	Sex	Age	Type	Treatment Started	Treatment Ended	Duration	Reduction	Remarks
A. J.	F	2½ years	Bilateral	May 25, 1932.	Nov. 30, 1932.	6 months	Closed—Nov. 30, 1932.	Because of marked external rotation, bilateral closed reductions were done Nov. 30, 1932. Weight-bearing was started July 5, 1933, and child now has stable, painless hips, with a complete range of motion, no limp, negative Trendelenburg sign. The feet are straight ahead when walking.
V. T.	F	15 months	Right	Jan. 23, 1930.	Jan. 21, 1931.	12 months	Spontaneous—Aug. 6, 1930.	Weight-bearing was started Feb. 18, 1931. At present, hip is stable, painless, with a full range of motion, and no limp. (Figs. 2, 3, 4, and 5.)
V. B.	F	20 months	Left	Nov. 10, 1930. No traction was applied for the first 2 months of splint treatment.	June 29, 1932.	10½ months	Spontaneous—March 23, 1931.	Weight-bearing started July 15, 1932. At present, hip is stable, painless, with a complete range of motion and no limp. Skin traction materially aided the treatment. (Figs. 6, 7, and 8.)
D. R.	F	2 years	Left	Sept. 30, 1930.	July 10, 1932.	21½ months	Closed—July 10, 1932.	Hip has shown a remarkable tendency to reduce spontaneously and then to dislocate. A closed reduction was done July 10, 1932 and reduction was maintained with internal rotation until Dec. 28, 1932, when the hip again dislocated. Open reduction with a shelf operation was advised, but the child was removed to the Shriners' Hospital in St. Louis.
P. L.	M	7 years	Left	Jan. 15, 1932.	Sept. 23, 1932.	8¼ months	Spontaneous—March 16, 1932.	Weight-bearing was started in December 1932. Patient has not been seen since, but correspondence with the local County Health Physician reveals that the hip is stable, motion is good, pain is minimal, and the limp is but slightly noticeable. (Figs. 9 and 10.)
M. G.	F	3 years	Bilateral	March 9, 1932.	Nov. 8, 1932.	8 months	Closed: Left—Nov. 8, 1932. Right—Jan. 13, 1933.	Acetabula are shallow with inadequate roofs. Closed reductions on both hips were done, but the hips were dislocated upon examination, June 1, 1933. Open reduction with a shelf operation was done on the right hip in October 1933, and will be done on the left hip in January 1934.
G. Mc.	F	7 years	Left	May 6, 1932.	Aug. 31, 1932.	3¾ months	Closed—Aug. 31, 1932.	Weight-bearing in plaster was started Nov. 23, 1932. Plaster was removed Jan. 4, 1933, and motion started. Patient now has complete range of motion, no limp, no pain, negative Trendelenburg sign, and the hip is perfectly stable.
H. R.	F	5¾ years	Right	May 24, 1933.	Still on splint.	———	Spontaneous—June 26, 1933.	The acetabulum is of fair depth and contour, but rather irregular. The hip reduced easily and spontaneously in 33 days. We plan to continue to hold the hip in the position of wide abduction on the splint for an additional 3 months before bringing it down to the straight position. (Figs. 11 and 12.)
C. K.	F	5½ years	Left	July 5, 1933.	Still on splint.	———	Spontaneous—July 12, 1933.	The hip reduced spontaneously in 1 week. The child was sent home on the splint in wide abduction, to remain in this position for 3 months.
K. S.	F	8¼ years	Left	Nov. 21, 1933.	Still on splint.	———	———	Treatment just started.

Fig. 11

H. R. Before treatment.

Fig. 12

H. R. Spontaneous reduction, thirty-three days after treatment on the splint.

tracted adductors. Skin traction seems to produce more relaxation than simple abduction alone, but spontaneous reduction of a dislocated hip by means of abduction alone has occurred in this series. The normal contour of the capsule of the hip joint is essentially cylindrical, it being attached around the acetabulum proximally and around the neck of the femur distally. Prolonged upward riding of the head on the ilium produces a distortion of this essentially cylindrical design and causes the much described hour-glass constriction of the capsule. Traction aids in overcoming this distortion. In addition, traction causes less pressure to be put on the head of the femur during the time of treatment, and in this manner tends to minimize the trauma to the abnormal underdeveloped head of the dislocated femur.

Age is apparently no great barrier in the splint treatment, since several of our cases have been those of unilateral dislocations in children ranging from five to seven years of age. All of these have been successfully reduced.

SUMMARY

A résumé of cases of congenitally dislocated hips treated by means of the abduction-traction splint is hereby presented as a supplement to the original report. The method of treatment has certain distinct advantages over other types of treatment:

1. There is no trauma, as abduction takes place gradually over a long period of time, thus permitting gradual stretching of the soft parts.
2. There is no danger of injury to the upper femoral epiphysis or to its blood supply.
3. There is no scar-tissue formation or other fibrosis which accompanies severe manipulations or open reductions and, consequently, there is less danger of limitation of motion after reduction has been accomplished.
4. If closed reduction is necessary, because of rotation of the head and neck of the femur, it is exceedingly easy to do if gradual abduction has taken place for several weeks.
5. It is not necessary to hospitalize the child for long periods. Practically all of our patients have been treated at home.
6. There is no difficulty due to pressure sores or skin irritations.
7. Hips in children of six and seven years of age have been successfully reduced, and almost perfect function has resulted.

It is evident that the method will not succeed in all cases, but it is our conviction that it should be given a fair trial before resorting to other procedures.

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OSTEOGENESIS IN CHRONIC PLEURISY

BY SYDNEY M. CONE, M.D., F.A.C.S., PIKESVILLE, MARYLAND

From the Pathological Laboratory of the University of Maryland

That passive congestion and oedema stimulate bone formation has already been shown by the author in previous communications [1]. The effect of fluid accumulated at and in the bone has been shown in cases of hypodermoclysis (Autopsies 1163, 1283, 1345), where the ribs were punctured. A similar effect has been produced in experiments on guinea-pigs by puncturing the bone and injecting saline solution.

New bone formation on the pleural side of the rib has also been found in chronic pleurisy. In 1100 autopsies all the cases of chronic pleurisy, sixty in number, demonstrated osteogenesis at the rib. At autopsy there was evidence of swelling of periosteum and cortical bone, as in three acute cases of hypodermoclysis. The same condition was evident at autopsy following experimental injection of salt solution into bone in animals. The lacunae and bone cells were enlarged and in many cases the nuclei of the bone cells were dividing. The lamellae were widened and interlamellar spaces were evident.

Fig. 1

Autopsy Specimen 1832. Rib showing new periosteal bone at pleura.

In the chronic cases, where fibrin and connective tissue with new congested blood vessels are adherent to the thickened periosteum of the rib, new bone is seen in the form of irregular osteophytes (nodules) or regular lamellated bone containing haversian canals (Fig. 1). This bone is usually found along the surface of the rib. Sometimes it is seen in the pleural adhesions.

In one case (Autopsy 1549) described by Stein [2], bone growths were found in the surrounding adhesions as well as at the rib.

The author has written of bone formed around the rib in syphilis, refer-

ring to similar formations in chronic pleurisy [3]. However, in pleurisy the new bone is confined to the pleural aspect of the rib.

CONCLUSIONS

Inasmuch as the cases of acute pleurisy with serous effusion, the cases of hypodermoclysis, and experiments with saline injection into cortical bone and periosteum present swelling of periosteum and bone with enlargement of lacunae and interlamellar spaces and activity of the bone cells and periosteal cells, the writer judges these to be a preliminary step to the formation of new bone. The bone is softened, calcium salts are carried into surface-degenerating tissues, and the modified, slowed, congested circulation stimulates the formation of new bone.

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SMALL BONE GRAFTS *

BY W. S. KEITH, M.B., TORONTO, CANADA

From the Department of Surgery, The University of Chicago

Since the operation of bone grafting became a common procedure, surgeons have occasionally been tempted for various reasons to cut their grafts into pieces or chips. Sometimes even bone powder or bone dust has been used. A number of operations of this nature have been done on experimental animals, with varying results. Macewen[1] transplanted homogenous grafts of this type into bony defects in young dogs, and found that the mass of bone chips without any periosteum produced a large callous mass between the ends of the fragments and, later, solid bony union. Hey Groves[2] did autogenous transplantations of bone chips and ground living bone in adult cats, and found that there was very little proliferation of new bone from the fragments. The ground bone was absorbed in a few weeks. Non-union invariably resulted. In recent years small fragments of bone have been used in some of the operations for spinal fusion. Either these have been obtained locally or they have been chipped from the tibia. Thus, and in the Hibbs type of fusion, many small grafts are created intentionally or otherwise. In other operations for fixation of joints, notably arthrodesis of the tarsal joints, small fragments of bone have been tucked into crevices between the bared bony surfaces. It was with a view to determining the fate of these small grafts that this investigation was carried out.

The differences induced by fragmentation are best studied by making the fragments very small. In this way the supporting function of the graft is reduced to a minimum, but better coaptation with bones or fragments to be fused is obtained. The survival of osteogenic cells, provided they are undamaged in the fragmenting process, should be at the maximum because of increased accessibility of tissue fluids; and the rapidity of absorption of necrotic bone should be great. When the graft is not needed immediately for supporting function, there may be an advantage derived from fragmentation.

EXPERIMENTS

Dogs, which have been classed as young, immature, adult, or old, were used throughout these experiments. The right radius was operated on and the limb immobilized in a plaster cast during the period of healing. Sixteen experiments are reported, in all of which there was healing without infection.

In Experiments 1 to 10 shavings of living bone were replaced between

* This work was done under a grant from the Douglas Smith Foundation for Medical Research.

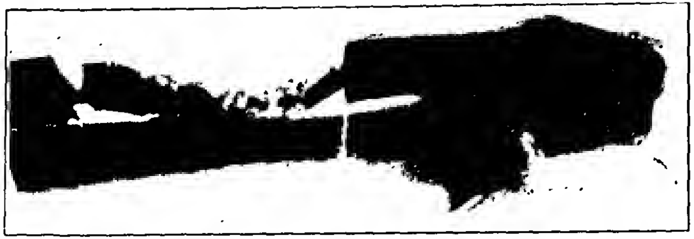

FIG. 1

FIG. 2

EXPERIMENT 1. Living shavings of cortical bone replaced in defect of radius of young dog.

Fig. 1. Shows roentgenogram of specimen seventeen days after operation. Shadow produced by both shavings and new bone.

Fig. 2. Section showing new bone (*A*) formed about dead shaving (*C*). *B* is new periosteum.

EXPERIMENT 2. Living shavings of cortical bone replaced in defect of radius of young dog.

Fig. 3. Microscopic section showing remnant of dead cortical shaving (*A*) surrounded by new bone (*B*).

Fig. 4. Shows roentgenogram of specimen thirty-one days after operation. Shadows of new bone, on fragment ends and in gap, extensive and homogeneous in places.

FIG. 3

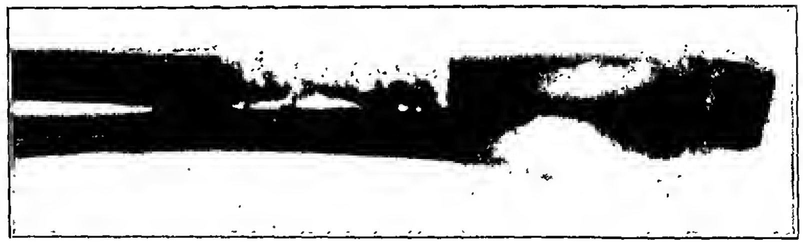

FIG. 4

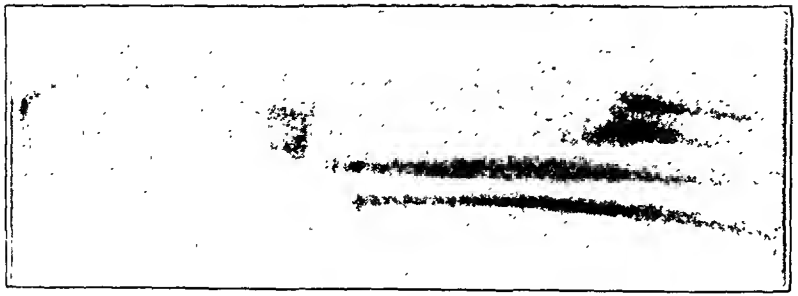

Fig. 5

Fig. 7

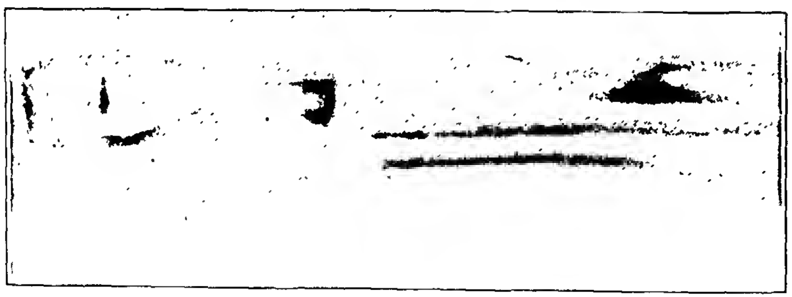

Fig. 6

Fig. 8

Experiment 3. Living shavings of cortical bone replaced in defect of radius of young dog. Roentgenograms: Fig. 5, twenty-three days; Fig. 6, thirty-nine days; Fig. 7, fifty-six days; and Fig. 8, ninety-two days after operation. Animal sacrificed; microscopically no trace of the shavings left.

FIG. 9

FIG. 10

EXPERIMENT 4. Living shavings of cortical bone replaced in defect of radius of young dog.

Fig. 9. Roentgenogram ten days after operation.

Fig. 10. Roentgenogram of specimen obtained forty-one days after operation.

and around the ends of the fragments. In Experiments 1 to 7 the operations were carried out as follows: Part of the shaft of the radius was exposed through a longitudinal incision and the soft tissues were dissected from the bone on all sides, leaving the periosteum intact. The interosseous ligament was divided over a distance of about one and one-half inches. The periosteum was incised about one-eighth to one-fourth of an inch from the proposed saw cuts and was reflected toward and beyond the sites of these saw cuts, so that one-fourth to one-half of an inch more of periosteum than of bone was removed in each case. The soft tissues were retracted, and from three-fourths to one and one-half inches of shaft was removed. The periosteum was removed from the excised bone and its surface was scraped with a knife. The bone, which at intervals was moistened with saline, was sawed in two longitudinally and the marrow and endosteum were curetted out. A small sterile metal plane and a vise were used to cut the bone into fine shavings. Only two very small slivers of bone were discarded in each case. The shavings were replaced in the gap between and around the ends of the fragments. The deep tissues were closed with catgut and the skin with silk. In Experiments 8 and 9 the periosteum was removed from the excised fragment of bone, but the bone was not scraped and the marrow and endosteum were not curetted out. In Experiment 10 the fragment of bone was removed by subperiosteal dissection. It was cut without removal of the marrow and endosteum and the shavings were replaced in the periosteal tube which was then closed. In Experiments 11 and 12 the operations were identical with those in Experiments 1 to 7, but the bone was boiled for ten minutes before being cut into shavings. In Experiment 13 freezing for ten minutes in liquid air was substituted for boiling. The fragment of bone

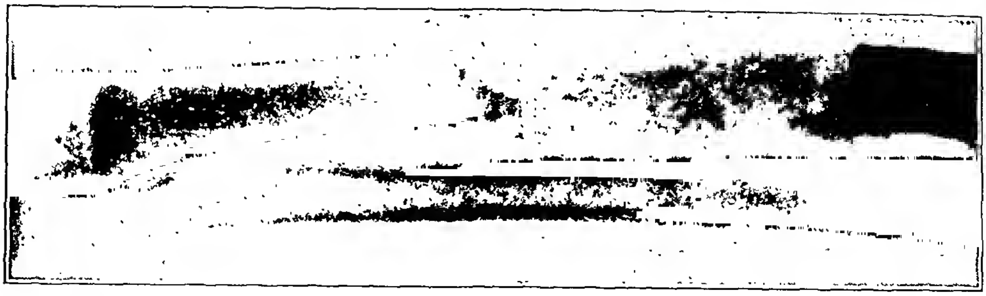

Fig. 11

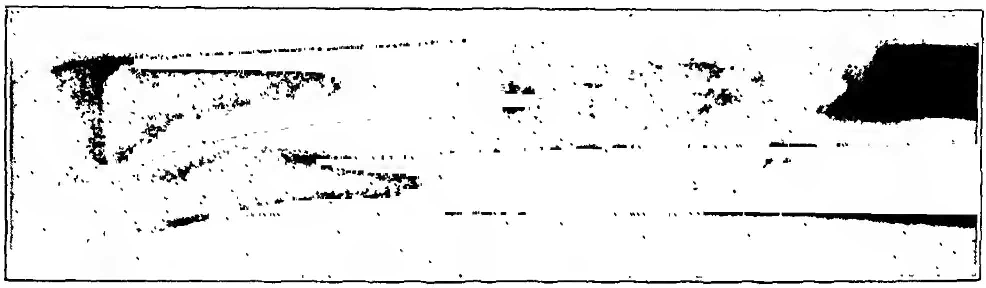

Fig. 12

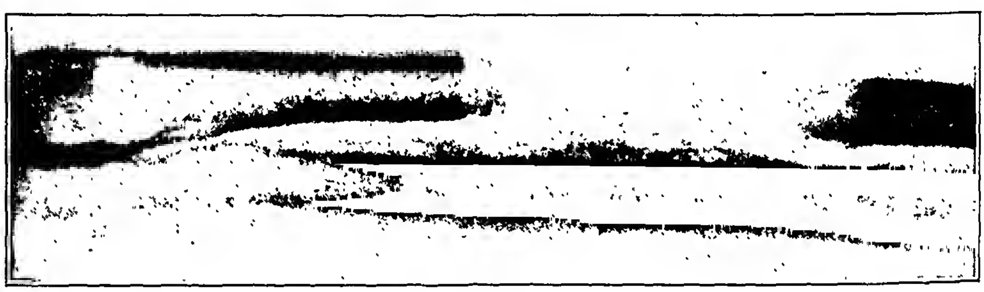

Fig. 13

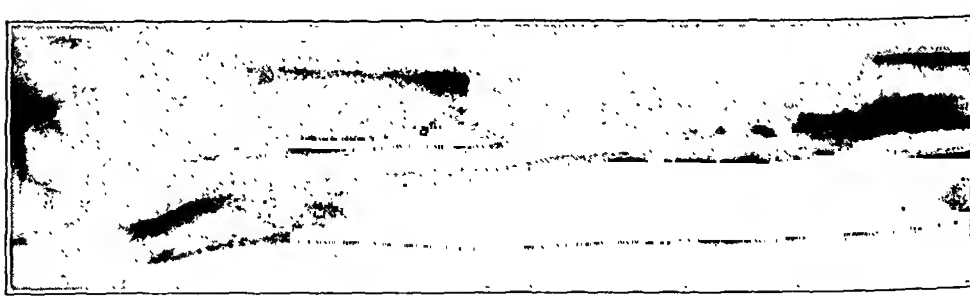

Fig. 14

was placed in saline in a brass cylinder and lowered into liquid air. There was survival of some cells with new bone formation in this case, and similar results were obtained in another set of experiments to be reported later, in which carpal and tarsal bones were frozen for ten minutes. This finding was a surprise. In Experiment 14 the bone was removed by subperiosteal dissection and was boiled for ten minutes; the shavings were replaced in the periosteal tube. In Experiments 15 and 16 the bone was removed by subperiosteal dissection; the periosteum was closed without any bone being replaced. In these two latter experiments a few shavings of cortical bone were placed in the rectus muscle. Brief protocols are

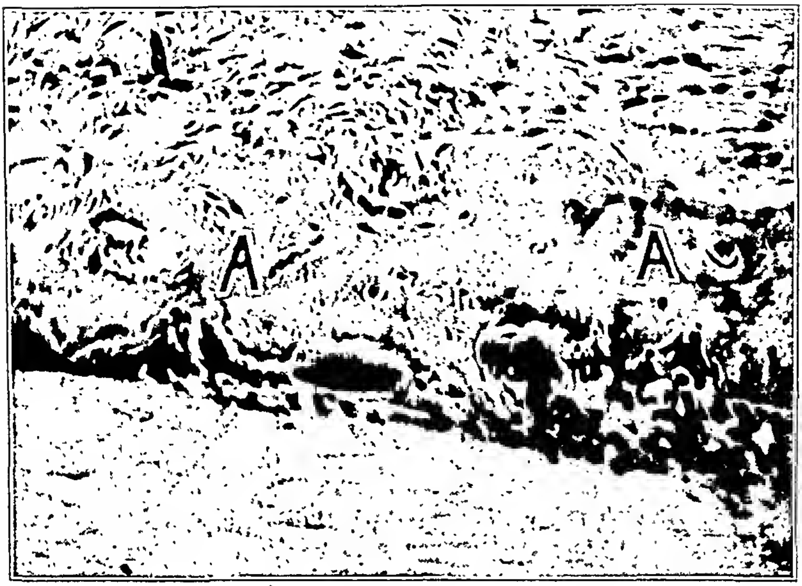

FIG. 15

EXPERIMENT 5. Shavings of living cortical bone replaced in defect of radius of an adult dog.

Roentgenograms: Fig. 11, twenty days; Fig. 12, twenty-four days; Fig. 13, forty-one days; and Fig. 14, sixty-two days after operation.

Shavings died and absorbed, with little new bone formed from them, as shown by gradual disappearance of its shadow with only incomplete replacement by that of the new bone. Microscopic examination showed remnants of shavings that had become necrotic and evidence of absorption of some of the new bone (*A*) that had been laid down (Fig. 15).

given with the roentgenograms in each experiment. The x-ray appearance of the bone and bone shavings immediately after operation is shown in Experiment 13.

DISCUSSION

From the experiments on young and immature animals, the conclusion may be drawn that a large number of osteogenic cells survive, particularly around the periphery of the mass of shavings, and that this results in the formation of a considerable amount of new bone. In Experiments 2, 3, 4, and 8, there has been an almost complete bridging of the gap by new bone in from twenty to thirty-five days. Should there still remain doubt in anyone's mind as to the ability of young cortical bone to regenerate in the absence of periosteum and endosteum, Experiment 3 should remove that doubt. When the bone was boiled, as in Experiments 11 and 12, there was neither invasion of the mass of shavings by osteogenic cells from the ends of the fragments nor any evidence of metaplasia of surrounding connective-tissue cells to bone-forming cells. The osteogenic cell appears to be the same, whether found in cambium layer of periosteum, endosteum, or scattered throughout the substance of the bone. In each of Experiments 2, 3, 4, and 8, it is noticeable that there is some degree of non-union of the mass of new bone with the end of the distal

FIG. 16

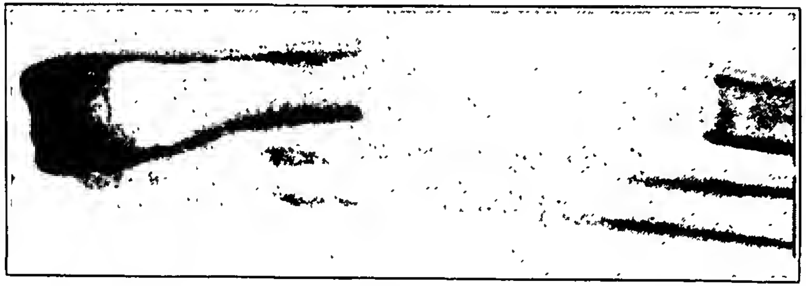

FIG. 17

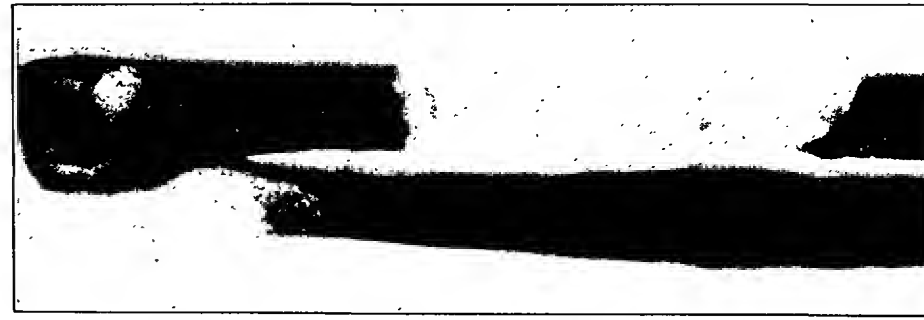

FIG. 18

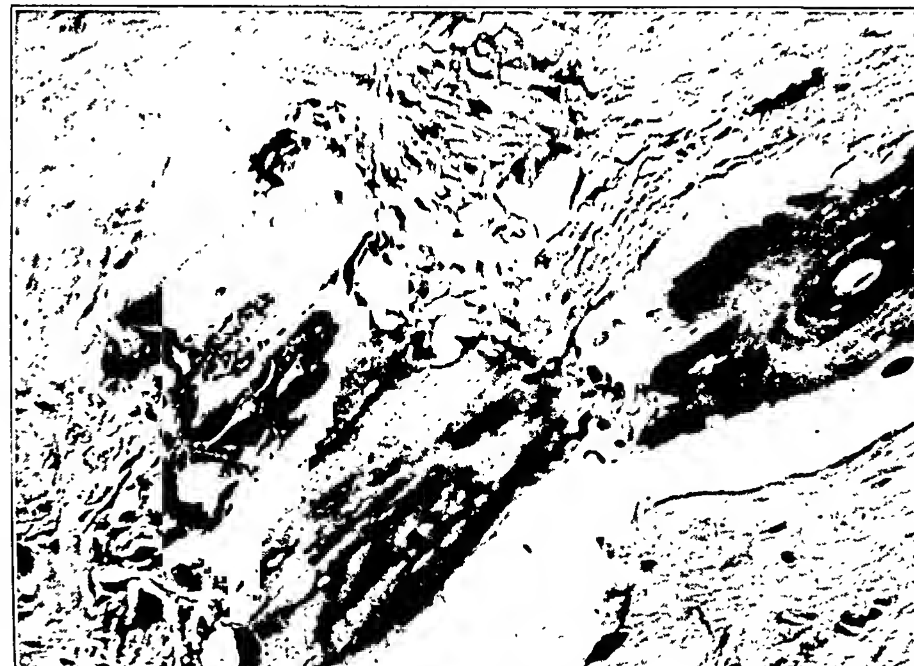

FIG. 19

EXPERIMENT 6. Shavings of living cortical bone replaced in defect of radius of adult dog.

Fig. 16. Roentgenogram eighteen days after operation.

Fig. 17. Roentgenogram of specimen obtained thirty-nine days after operation.

Bone quite hard, but not flinty as in old dogs. Grafts extensively absorbed with very little new bone formation from them.

EXPERIMENT 7. Shavings of living cortical bone replaced in defect in radius of old dog thirty-one days after operation. Mass of shavings felt but could be moved on fragment ends.

Fig. 18. Roentgenogram of the specimen obtained forty-six days after operation.

Fig. 19. Extensive absorption of necrotic shavings shown by microscopic examination, but no new bone seen.

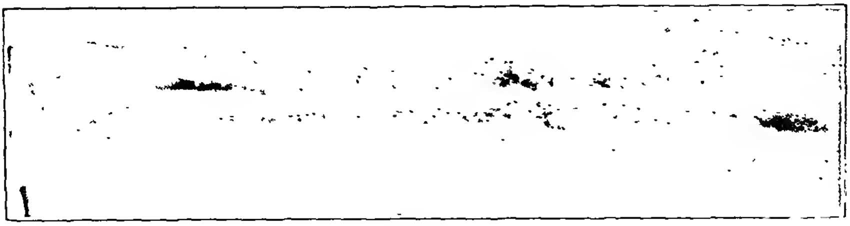

FIG. 20

FIG. 21

FIG. 22

EXPERIMENT 8. Shavings of living bone, composed of cortex and endosteum, replaced in defect of radius of immature dog. Periosteum removed.
Roentgenograms: Fig. 20, twenty-six days; Fig. 21, fifty-seven days; and Fig. 22, 210 days after operation.

fragment. This is due to the more extensive necrosis of the end of this fragment, as compared with the end of the proximal fragment. At operation it was sometimes noted that the end of the proximal fragment bled more than the end of the distal fragment. The bleeding was from the medulla of the bone chiefly. This feature of these experiments serves to emphasize the utmost importance of the blood supply of the graft and its bed. One of the cardinal principles of bone grafting is that great care should be taken in all operative procedures to disturb the blood supply of the fragments as little as possible and to make conditions as favorable as possible for the reestablishment of the circulation of the surface of the graft. The bridge of new bone having formed across the gap, the stimuli of slight weight-bearing and later full weight-bearing result in complete reconstitution of the shaft of the bone.

Macewen[1] claimed that a complete gap in the radius of dogs of the same ages as those used in these experiments was filled by new bone, resulting from the activity of osteogenic cells flowing out from the ends of fragments and from increased growth at the epiphyseal lines. In Experi-

Fig. 23

Fig. 24

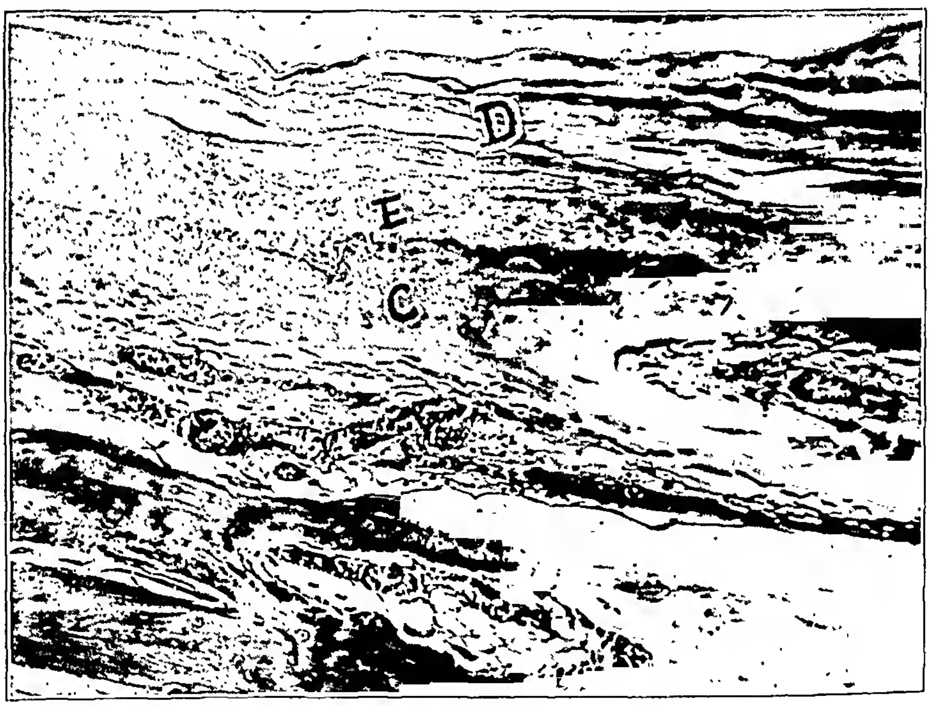

Fig. 25

Experiment 9. Shavings of living bone, composed of cortex and endosteum, replaced in defect of radius of immature dog. Periosteum removed.

Fig. 23. Roentgenogram fifty-eight days after operation.

Fig. 24. Roentgenogram of specimen 140 days after operation.

Fig. 25. Photomicrograph of periphery of regenerated segment. Note the hyperplastic appearance of the cambium layer (*E*).

ments 1, 2, 11, and 12, there is very little new bone formation on the ends of the fragments and, as noted above, osteogenic activity is much retarded on the end of the distal fragment. In Experiments 3 and 8, there is no evidence that increased growth at the epiphyseal lines results in shortening of the gap.

FIG. 26

FIG. 27

FIG. 28

FIG. 29

EXPERIMENT 10. Shavings of living bone, composed of cortex and endosteum, replaced in subperiosteal defect of radius of immature dog. Periosteal tube sutured about shavings.

Fig. 26. Roentgenogram sixty days after operation.

Fig. 27. Roentgenogram of specimen obtained 125 days after operation.

EXPERIMENT 11. Boiled cortical shavings replaced in defect of radius of young dog.

Fig. 28. Roentgenogram of specimen obtained nineteen days after operation. The shavings were less adherent to surrounding tissues than in Experiment 1, in which they were not boiled.

Fig. 29. Shows microscopic appearance of new shavings (*s*) imbedded in connective tissue (*c*). No new bone found in defect.

FIG. 30

FIG. 31

EXPERIMENT 12. Boiled cortical shavings replaced in defect of radius of young dog.

Fig. 30. Roentgenogram of specimen thirty-one days after operation. Density of shavings already much reduced.

Fig. 31. Microscopic section of shavings imbedded in connective tissue and undergoing absorption. No new bone in the defect.

In adult animals, although there is some survival of osteogenic cells, new bone formation is slow and scanty. In these experiments a complete bridge was not formed in any case. The stimulus of weight-bearing not being available, absorption of living bone and of dead bone proceeds more as when bone is transplanted into soft tissues. Experiments 5, 6, and 7 confirm those of Hey Groves [2]. When a solid bone graft is used and is mechanically fixed to the fragments, the stimulus of use, however slight that use may be, operates from the first. When bone shavings are used, the growth factor must operate more nearly alone, until there is a bridge of new bone across the gap. In adult animals this growth factor is insufficient to produce the bridge. In a review of free-tissue transplantations, Phemister [3], in discussing each type of tissue, refers to the favorable influ-

FIG. 32

FIG. 33

EXPERIMENT 13. Frozen cortical shavings replaced in defect of radius of young dog.

Fig. 32. Roentgenogram immediately after operation.

Fig. 33. Roentgenogram of specimen obtained thirty-five days after operation. Density of shadow reduced.

Microscopic examination showed death and extensive absorption of bone in the shavings, as shown in Fig. 34. A small amount of new bone was seen springing from the surface of dead shavings in places, as at *A* in Fig. 35, *C* being the dead bone. Freezing had killed all except a few osteogenic cells, which had formed new bone.

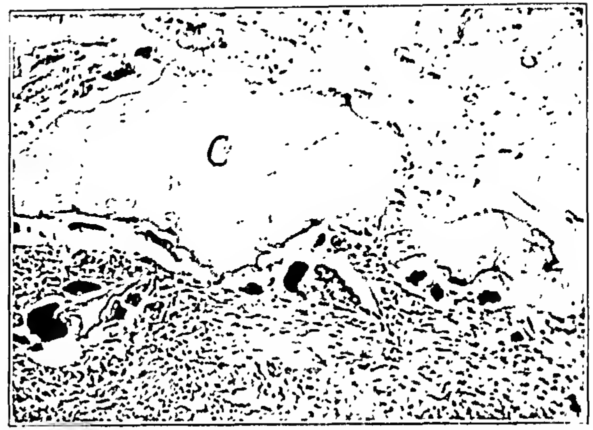

FIG. 34

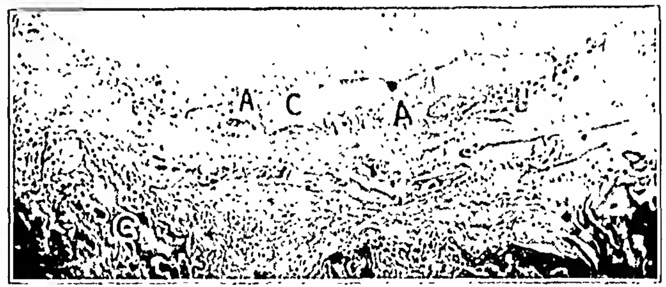

FIG. 35

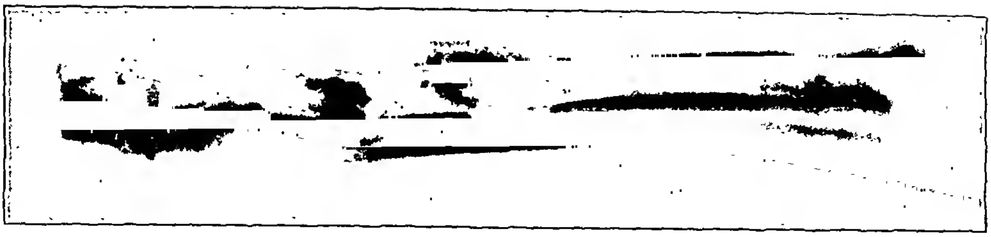

Fig. 36

Experiment 14. Boiled bone shavings of a subperiosteally resected segment of radius in a young dog reinserted in the periosteal tube. Periosteum extensively damaged at distal end of gap.

Fig. 36. Roentgenogram of specimen obtained twenty-three days after operation. Periosteal new bone shown on distal end of proximal fragment and in course of defect, but slight at distal end.

ence of function on the ultimate survival and growth of the transplant. The function of bone as a supporting tissue is almost completely destroyed by fragmenting it. Therefore, the general principle may be laid down that it is fallacious to fragment a bone graft more than is absolutely necessary for the purposes of the technique of the operation. The consequences of fragmentation of bone grafts are less serious in the young than in adults, because of the greater tendency in the former to grow and to form new bone.

In much of the experimental work that has been done in the past, these marked differences in the behavior of grafts in young and adult animals have been partly masked by the fact that the grafts were large and the surface available for absorption was relatively small. As a consequence, whenever the choice of graft has been suitable and the technique of operation and subsequent fixation adequate, the results of bone grafting have been almost uniformly successful. Even in old animals, sufficient osteogenic cells have survived to initiate new bone formation and creeping substitution. The stimulus of function has then been added. The inaccessibility of the bulk of the graft to the absorptive process has prevented its rapid dissolution.

From its position and its reaction to injury, there can be no doubt that the cambium layer is of importance in bone regeneration. In young animals the periosteum, as it is elevated from the bone at operation, is capable of regenerating the shaft of the bone. This was demonstrated by Syme [4], Ollier [5], Rhode [6], Phemister [7] and others. In one experiment reported by Macewen, regeneration in a young dog did not take place after this operation. In Experiments 15 and 16 there was bone regeneration, roughly, in proportion to the ages of the animals. When considering these results in connection with bone grafting, it must be remembered that in subperiosteal resection the periosteum and adherent cells have an intact blood supply, a condition which never obtains when bone is grafted. By a study of the roentgenograms in Experiments 9 and 10, a further illustration of the activity of periosteum may be obtained.

In adult animals the periosteum, as elevated at operation, contains

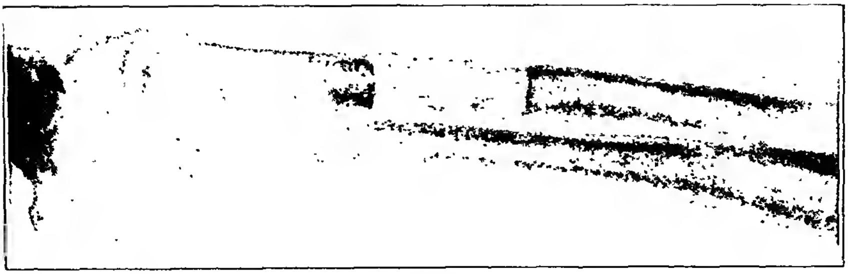

Fig. 37

Fig. 38

Fig. 39

Experiment 15. Subperiosteal resection of segment of shaft of radius of young dog. Living cortical shavings inserted into rectus abdominalis muscle.

Fig. 37. Roentgenogram twenty-three days after operation.

Fig. 38. Roentgenogram of specimen obtained forty-four days after operation.

Fig. 39. Microscopic section of transplanted bone, showing much newly formed bone about pieces of necrotic shavings that were being absorbed.

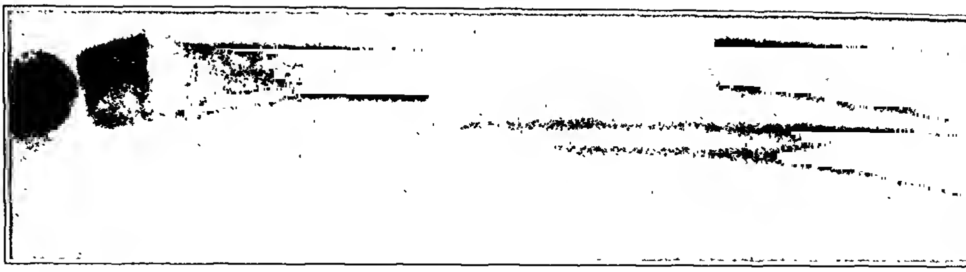

FIG. 40

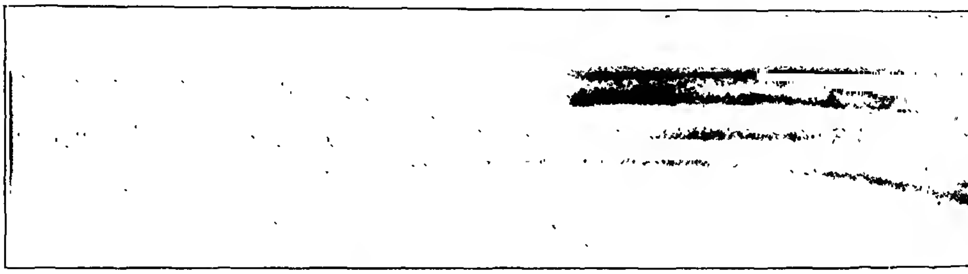

FIG. 41

FIG. 42

EXPERIMENT 16. Subperiosteal resection of segment of radius in an almost mature dog. Living cortical shavings then transplanted into rectus abdominalis muscle.

Fig. 40. Roentgenogram seventeen days after operation.

Fig. 41. Roentgenogram of specimen obtained thirty-eight days after operation.

Fig. 42. Microscopic section showing new bone transplant to rectus, much less in amount than in Experiment 15, in which the dog was much younger.

few if any osteogenic elements. Rhode [6] states "In our experiments on old animals we were never able to obtain bone regeneration from the periosteal tube". In connection with some other experimental work, ribs were removed from adult dogs by subperiosteal dissection on several occasions. There was never regeneration of a rib. In young dogs, however, ribs were regenerated following the same operation. McWilliams [8] usually found regeneration of ribs following subperiosteal resection of the bone. He does not give the ages of any of his experimental animals. The cambium layer of adult animals can be stimulated by trauma to proliferate, as has been shown by Ollier [5], Hey Groves [2], and Brooks [9]. The latter suggested that in old patients, when a bone-grafting operation is contemplated, the periosteum in the region of the graft might be stimulated to proliferate by making saw cuts in the cortex of the bone about a week before transplantation.

Phemister [3] has emphasized the fact that osteoconduction or migration of osteogenic cells into the graft from adjacent fragments is limited. This fact is illustrated in Experiments 11, 12, 13, and 14. In no case has new bone formation spread more than about one-eighth of an inch, from its apparent source, in the direction of the long axis of the bone, though bone salts were available. In Experiment 14, where the distal part of the periosteum was badly damaged, there is no x-ray evidence of new bone formation in this region, although the more proximal periosteum appears to be laying down new bone.

That metaplastic bone formation plays any part in the regeneration of bone grafts has never been proved. All the evidence derived from experiments with bone transplants points to the specificity of osteogenic cells in the new bone formation associated with bone grafting. In Experiments 11 and 12, where shavings were boiled, there is no sign of metaplasia of connective-tissue cells to osteogenic cells, although these are young animals and sufficient time has elapsed for metaplastic bone to form. Huggins [10] has shown that, under the unusual stimulus of proliferating transplanted bladder epithelium, a locomotive connective tissue—as rectus abdominus fascia—with which it has been placed in contact will regularly form bone. No such metaplasia takes place from simple trauma to locomotive connective tissue devoid of osteogenic elements.

SUMMARY

When small fragments of the bones of young dogs are used as autogenous grafts, there is a considerable tendency to form new bone. New bone formation is very much less marked when the experiment is carried out on adult dogs.

The tendency to proliferate and form new bone in these small grafts appears to be dependent upon the presence of living osteogenic cells in the grafts.

Osteogenic cells in small numbers are distributed throughout the cortex of the graft, as well as in the cambium layer of periosteum and

endosteum, and they get sufficient nutrition to survive. Boiling for ten minutes kills these cells and prevents osteogenesis.

The general principle is laid down that it is fallacious to fragment a bone graft more than is necessary for the technique of the operation, since minute fragmentation lowers both its supporting and its osteogenic functions.

It is emphasized that the intact blood supply of the bed of the graft and the cambium layer of the periosteum are as important for regeneration as is the density of the graft for supportive purposes. There is no evidence in these experiments that metaplasia of other connective-tissue cells to bone-forming cells plays any part in the new bone formation associated with bone grafting.

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A CRITICAL ESTIMATION OF THE PERSONAL INFLUENCE OF FOUR PIONEERS ON THE DEVELOPMENT OF ORTHOPAEDIC SURGERY IN NEW YORK

BY ROYAL WHITMAN, M.D., NEW YORK, N. Y.

In 1923, Dr. Newton M. Shaffer collected his more important papers in a volume entitled "Selected Essays on Orthopaedic Surgery"[1]. One of these was an address read in 1898 before the National Conference of Charities and Corrections on the Care of Crippled and Deformed Children, in which the following statement attracted my attention: "All, or nearly all, this advance in the use of modern methods of caring for the deformed poor may be traced to New York, and to the personal influence of four great men—viz., Dr. James Knight, the philanthropist and organizer; Dr. Charles Fayette Taylor, the mechanical genius and enthusiastic leader; Dr. Lewis A. Sayre, the impressive teacher and eminent author; and Dr. Henry G. Davis, who revolutionized the treatment of joint and spinal diseases, and whose originality and genius made him the father of American orthopaedic surgery."

Dr. Shaffer had served as a professor in two medical schools, as surgeon-in-chief to two hospitals, as an organizer and second president of the American Orthopaedic Association, and his intimate association with these pioneers entitled him to speak with authority. Yet his conclusion was so at variance with my own impression, that it suggested a personal investigation. This paper may be considered, therefore, not as a contribution to conventional biography, but, rather, as a critical study of literary remains to determine the relative importance of what the essayist calls the personal influence of these men in their own day, and of the value of their contributions to modern methods, viewed from the vantage ground of a later generation.

I. James Knight

The first in the essayist's order, James Knight, is naturally of especial interest to me as one of his successors. His portrait, which hangs in the reception room of the Hospital for the Ruptured and Crippled, represents an elderly man of kindly mien, wearing a brown wig, and holding in his hand his book entitled "Orthopaedia"[2]. The painter was not an expert, nor was the sitter an especially favorable subject, but the result was evidently accepted as satisfactory by those directly concerned, and to me it has seemed to personify, in a sense, the quality of the man and the character of his work.

Dr. Knight's introduction to orthopaedic surgery was by way of the treatment of hernia, for which he devised an effective truss. This, he states, "served as an incentive to the construction of appliances for the restoration of impaired powers of locomotion in children, laboring under

deformities both congenital and the sequelae of infantile paralysis. Other deformities resulting from constitutional impairment led to a careful study of the pathological conditions, such as caries of the spine terminating in spinal or psoas abscess. These latter ailments were carefully considered and a careful régime with proper sanitary regulations and conditions were found the primary requisition of proper treatment. Such conditions, we concluded, were only attainable in the highest degree in a hospital of proper construction. With this impression we introduced the initiatory efforts in our own dwelling". This was in 1863, and, as Dr. Knight's practice "had been confined to ailments of this character for twenty years", he must have been in late maturity at the time. The scope of this practice, as represented in the "Orthopaedia", was evidently defined by the indications offered for bandaging and bracing, since it included hernia, varicose veins, hemorrhoids, procidentia uteri and ectopia vesicae.

The model hospital constructed under his supervision in 1870 provided the opportunity for development of the system which he had initiated. Here he lived with his family and assistants, giving his full time to the indoor and outdoor patients, and receiving a salary from which he accumulated a considerable estate. He treated private patients also, and turned the proceeds into the hospital funds, thus anticipating by many years recent developments of this character.

The great majority of the indoor cases were of the tuberculous class, the so called synovitic diseases, and, as the patients remained in the hospital for indefinite periods of months or years, "physical training and instruction both religious and secular were part of the daily life of the patient". Bodily activity was enforced. "No child able to hold up its head is ever kept in bed during the day, and all able to walk by pushing a chair before them have thus to exercise for a certain time, and those unable to walk from pain and tenderness are supplied with rolling chairs." "Even the most vigorous and robust constitution would inevitably be weakened and brought to a state of etiolation by long continued repose, and in a weak constitution the malady would be proportionately increased."

According to the author of the "Orthopaedia", "the subject matter may be considered as the varied and consolidated experience of many practitioners modified by our judgment", and, "although the work has been greatly condensed he trusts it will be perfectly comprehended by the readers". It is my impression, however, that Dr. Knight's expositions serve rather to embellish the narrative than to indicate the principles which might guide a student in applying treatment. For example, he states that "tonic medicines do not act directly upon the physical organization but slowly through the vital functions as excitants. A proper cohesion of living molecules in organized tissues is essential to the performance of normal functions and a moderate augmentation of this vital cohesion may give increased energy to the function. There are conditions

when tonics are inimical, when they may tend to increase depression by an exhausting influence, there being no latent power to incite into renewed action". He concludes, therefore, "that the judicious use of tonics in the treatment of chronic disease can only be determined by a long career of vigilant observation in variously conditioned patients" and that "this knowledge is obtainable only under the most favorable circumstances", such, it may be inferred, as were only at the command of the author.

Dr. Knight was an exponent of what he defined as "conservative, or expectant", as contrasted with "adventurous" treatment, "by properly enforced hygiene, by regular and nutritious dietary, by mechanical appliances to secure rest for an invaded joint but avoiding every grave surgical interference and employing every means that contribute to the strength, vitality and comfort of the patient".

Therapeutically he was less conservative. He administered mercury as a routine in "cachectic cases until the gums were affected". He advised the direct local application of molasses or cod liver oil for ulcers of the cornea, and Spanish-fly blisters, sixteen square inches in area, for eight hours as a derivative in the acute stage of hip disease.

Dr. Knight was primarily an exponent of "surgico-mechanics" and, according to the essayist, he had more than the ordinary versatility in adapting mechanical means to pathological ends. This is certainly a modest estimate of his ability in his chosen field. Furthermore, it is evident that he was considered behind the times by the other members of the group, because he did not approve of the so called extension which "had revolutionized the treatment of joint and spinal disease". He was, indeed, so strongly opposed to it "that he did not permit any treatment of this kind in the institution".

Dr. Knight appears to have been immune from criticism from any source. As the head of his household, he was in absolute control of every department. No trained nurses or skilled mechanics were employed, and with the money received from the city, from pay patients, and from contributions, the hospital was self-supporting. It may be inferred, therefore, that the trustees were in full accord with a management that carried out the intentions of the incorporators and relieved them from all financial responsibility. He lived under what he considered ideal conditions for observation and treatment, and based his conclusions, therefore, on an experience far greater than could be attained elsewhere. Under his ministrations "seventy-five per cent. of the ordinary conditioned patients laboring under synovitic disease were restored to self-sustaining ability". And, in the outdoor department, treatment was provided for every curable variety of deformity, furnished free, or at a charge sufficient only to pay the cost of construction.

The evidence at command supports the essayist's statement that Knight was a philanthropist and a genuine friend of the crippled child. It is equally apparent that, in the natural exercise of these attributes, he

had prospered materially, socially, and professionally, and was passing his declining years in congenial surroundings, fully justified in what appears to have been complete self-satisfaction. Originally an obscure practitioner, he had become the head of an established institution which, although it supported the cumbersome title of the Hospital of the New York Society for the Relief of the Ruptured and Crippled, was popularly known as Dr. Knight's Hospital, and properly so, for he made it.

It is evident that the scope of Dr. Knight's practice was defined by his own capacity and that it was adapted only to the conditions that he controlled. The essayist, writing in 1898, speaks of him as even then a neglected and unrecognized pioneer. And the hospital which he founded, over whose entrance he would have had "Conservatism" engraved, which, according to the essayist, implied surgical nihilism, had already become a leading exponent of the adventurous treatment that he deplored.

II. Henry G. Davis

Davis and Knight seem to have more in common than the other members of the group. They were of similar age and professional standing, of the same school of therapeutics, and equally opposed to operative intervention. Dr. Knight, when he "initiated his hospital in 1863 had confined his practice to ailments of this character for twenty years". Dr. Davis' book [3], published in 1867, representing "thirty years' investigation", probably served as a model for the "Orthopaedia". It was entitled "Conservative Surgery", which was defined by a quotation from Hippocrates as a "mode of cure, and it neither requires cutting, burning, nor any other complex means". The author trusts "that the time is not far distant when intellectual efforts to preserve the human form intact . . . . will be considered as humane and as honorable and will be as highly appreciated, as is the devising of some new mode of mutilating it at the present time".

"Conservative Surgery" is less comprehensive in its scope than the "Orthopaedia". The first chapter is on fractures and dislocations, the last a description of a pessary for uterine displacements, and the longest on synovitis, which includes every variety of joint disease.

The chief purpose of the book was to exploit "continued elastic extention" as a potent and comprehensive treatment of deformity and joint disease. This, he states, is a field so fruitful that "we could wish for another term of life than that allotted to man, to enable us to continue these investigations".

A casual reader might infer from the lack of any indication tó the contrary, that traction, the so called extension, originated with Dr. Davis.

This, however, had been in use for many years before his book was written. He employed it, doubtless, with more intelligence and assiduity than his predecessors and enforced the principle that it should be applied in the line of deformity. Dr. Davis' qualification as a "revolutionist" rests on the claim that constant traction applied by his method will actually separate joint surfaces from one another and yet permit a freedom of motion that will preserve the nutrition of the limb.

In a paper published in 1890 [4] he still asserts that his hip splint assures freedom of motion without friction in locomotion; that there should be no mortality from hip disease, if thus treated, and that recovery may be assured without greater destruction of the joint surfaces than existed at the commencement of the disease. And, in his last communication [5], he states that he first used extension for diseased joints, that "extension does not stretch parts but excites nutrition and thus adds to their length", and that, "if continued extension is properly applied in ulcerated joints until the diseased bone has healed, full motion will be restored".

It is evident that Davis' claims were not conceded by his contemporaries. Dr. Knight permitted no treatment by traction in the institution that he controlled, "believing it to be injurious by impairing the vital energy of the limb". In discarding traction he was in accord with Thomas, "the protagonist of rest, enforced, uninterrupted and prolonged", who asserted "that its application involved a fractional degree of fixation which is sufficient to mask the evil of this ridiculous malpractice".

As to Davis' spinal brace, Taylor, characterized by the essayist as a mechanical genius, and who may be accepted as an authority, states, "The only impression made by it upon me was admiration for the ingenuity which could devise a means rendering it utterly impossible to effect any mechanical purpose at all".

Sayre [6] gives to Davis the credit for devising an instrument permitting extension with motion, but states that "as Dr. Davis since that time has taken out a patent on his instrument, and as others have since been devised by various persons that are so much more efficient without the objectionable features of Davis's original instrument, it is not necessary to make any further reference to it".

It is evident that both Sayre and Taylor accepted Davis' theory of the desirability of movement without friction in the treatment of diseased joints, but used their own appliances to assure it.

According to Sayre, "*motion* is as essential in retaining a healthy condition of the structure about a joint as light is essential in retaining a healthy condition of the eye; for the ligaments around a joint will become fibrocartilaginous, or even osseous, if motion is denied them, particularly if a chronic inflammation is going on within the joint with which they are connected".

Dr. Davis complained bitterly of the injustice of the appropriation of his discoveries by others without due credit,—his hip splint by Sayre, his

back brace by Taylor, his elastic tension straps by Barwell. He hopes that "our brethren will soon consider it as derogatory to a man's standing in the profession to rob a brother of his discoveries, as it is to patent a splint".

It would appear that not only were Davis' braces supplanted, but the theory on which they were constructed was also discredited during his lifetime. For those who employed the "American treatment" of hip disease evidently regarded motion in a diseased joint as unavoidable rather than desirable. Even the essayist, in a paper on the treatment of hip disease, speaks of "the peculiar and perfect immobility" assured by the long traction brace, which was originally designed to permit motion without friction.

Davis' extravagant claims must have stimulated an interest in a neglected class of cases that was in some degree justified by the results. He alone of the four is credited by the essayist with originality and genius and, characteristically, his life appears to have been one of storm, stress, and disappointment. He did not, like Taylor and Knight, found a hospital to perpetuate his memory and, although what the essayist calls his "personal influence" must at one period have been much greater than that of either, he has preceded them on the road to oblivion. For, in a recent account of "American Explorers in Orthopaedic Surgery"[7], his name even does not appear.

III. C. Fayette Taylor

It is evident that the success of Knight and Davis was not due either to social influence or to educational advantages, technical or otherwise. Certainly Taylor's was not. Indeed, his medical training was perhaps the shortest on record, since it comprised a summer term, a winter term, and a spring term, all within a single year. Apparently he had no intention of practising medicine, but desired a medical degree simply as a qualification for work in physical culture. After graduation he conducted a gymnasium for several years and later devised many machines for mechanical exercises of what are generally known as the Zander type.

His interest in tuberculous disease was stimulated by his experience in the treatment of Pott's disease by exercises designed to check the progress of the deformity by developing muscular resistance. The onset of paraplegia in one of the cases convinced him of the futility of the only method then at his command. Shortly afterward, a similar case came under his observation and, since this was the most momentous occasion of his life, it will be described in his own words[8], thus providing an opportu-

nity to contrast the simplicity of his literary style with the verbiage of Knight and Davis.

"I then told her (the mother) as easily as I could the nature of the trouble and again endeavored to get away. But she still detained me and asked for further information of the nature of the disease, which I reluctantly gave her. 'How can this be?' she continued. 'To all appearances my child is as well as ever, as well as any child. She is not, and she has not been, sick so far as I know.' I replied, still insisting that there was a destructive disease in her spinal column. After listening, she said: 'Well, of course, it can be cured; it is discovered so early.' I had not then learned, and, thank Heaven, I never have learned, to lie to my patients, so I replied that, so far as I knew, there was no cure for it. She sat thoughtful a few minutes, and then asked: 'What am I to expect?' And I replied by telling her the progress of the disease in its downward course. She said: 'But how long will this be going on?' And I replied: 'For many years.' 'And what will be the result?' she asked. I told her. Then came the hardest question of all: 'Do you mean to say,' she said, 'that my little girl here, who has been always apparently a healthy child, and now appears to be so, who is still so plump and straight, must go down before my eyes, must suffer, may be confined to the bed with paralysis, with discharging abscesses, down through a series of years, becoming deformed and dwarfed and emaciated, distorted and disfigured, and there is nothing which can be done to prevent, or even to mitigate, such a terrible calamity?' There was but one answer at that time to be made. I made it, and bowed my head and left.

"But the impression I had received did not leave me; it has never left me. It burned into my brain as with a red-hot iron. It staid with me and followed me for weeks and weeks; in fact it never left me until the spinal assistant had been invented."

The "spinal assistant" is a type of support now so familiar that it seems almost incredible that steel bars placed on either side of a diseased spine, attached above and below to serve as a splint, should not have been used in a practicable form before his time. But, according to Taylor, all other supports were constructed on vertical support, which was an idea only, as there was neither a fixed point below nor above. Of his own brace, he writes, "The first real light broke in upon me when I gave hospitality to and finally adopted the term '*protection* to the diseased vertebrae'. . . . One evening, . . . just as I passed into the bright light pouring from an ice-cream saloon . . . the thought of the principle of action of a special instrument that would both have fixed points and afford perfect protection to the diseased vertebrae struck me. The sensation was almost awful. I jumped as if I had received a physical blow, and ran all the way home. . . . The next day I went down town and ordered an instrument, though I had no money and no patient with that disease". This was in 1858, and Dr. Taylor, as a young man of twenty-four, evidently suffered from a sense of social and professional inferiority. For, although this

brace seemed to him the result of an almost miraculous illumination, he walked up and down before the door of a prominent surgeon for half an hour before he could summon up resolution to invite his inspection of the appliance, and with a result that justified his apprehension.

It has been noted that Taylor's primary interest was in physical culture, and he still believed that motion in the diseased area was desirable if "perfect protection" might be assured. Thus his "spinal assistant" was "made with two hinges, allowing the instrument to bend backward but not forward, in order to allow the muscles to act when they wanted to, but to completely protect the affected vertebrae in case the muscles should tire and relax". This was justly criticized by Davis. Later, motion was checked by pads and screws. The back bars were extended over the shoulders, and leverage and pressure assured fixation at the site of disease. This brace, and the results which he attained by its use, established Dr. Taylor's reputation and turned his attention definitely to the mechanical treatment of chronic disease of the joints.

In 1866 he founded the Orthopaedic Dispensary and in 1872 he took charge of a ward at St. Luke's Hospital for the treatment of bedridden patients, but within a few years he retired to devote his entire time to private practice.

Although he was the only one of the group who did not write a book, he was a more constant contributor to medical literature, forty-two papers being listed under his name. Twenty-three of these may be classified as orthopaedic, and are chiefly concerned with lateral curvature of the spine and tuberculous disease. The other titles indicate a wider range of interest, such as "Carnomania", "Gofio: Food and Physique", "Sensation and Pain", "Emotional Prodigality", and the like.

One may conclude that Taylor, who died in retirement at the age of sixty-five, like Knight, led what might be termed a protected life, in the sense that he carried out a treatment, of which he was a master, on selected cases in his own institution, free from criticism and competition.

His son dedicated his "Orthopaedic Surgery" [9] to him as a pioneer, with the accompanying quotations:

> "I will not follow where the path may lead, but I will go where there is no path and I will leave a trail."—*Strode.*
>
> "I count on that man as happy who when there is a question of success looks into his work for a reply."—*Emerson.*

From which it would appear that, in the estimation of his successor and most intimate associate, Dr. Taylor had every reason to look backward on his professional life with complete satisfaction.

IV. Lewis A. Sayre

As contrasted with the other members of the group, Dr. Sayre was a far more important figure both in the professional and social scale. He alone of them had surgical qualifications, and was a surgeon in Bellevue Hospital as early as 1853. He was a founder of the Bellevue Medical School and the first Professor of Orthopaedic Surgery, under the comprehensive title of Professor of Orthopaedic Surgery, Fractures and Dislocations and of Clinical Surgery.

Dr. Sayre's book[10] entitled "Orthopaedic Surgery and Diseases of the Joints", published in 1876, as contrasted with the "Orthopaedia" of Dr. Knight, reads like a romance. It is introduced by the following quotation from Dr. Valentine Mott, which sets the keynote for the exposition: "It was my happy lot, even at my advancing time of life, . . . to have witnessed, also, the dawning as well as the meridian splendor of another new and illustrious era in the healing art; I refer to that beautiful and exact science, *limitedly* denominated *orthopedic surgery*".

Dr. Sayre states that his book is a response to numerous letters from eminent men here and abroad urging him to prepare a work setting forth his peculiar views on pathology and treatment. It purports to be an almost literal transcript of his lectures which are composed of clinical demonstrations and reports of cases illustrating his peculiar views and the efficiency of his methods. For example:

> Spastic paraplegia is induced or aggravated by an adherent prepuce which in the illustrative cases was relieved by circumcision.
>
> Club-foot in the majority of cases is caused by paralysis and the most effective treatment is elastic traction, supplemented by the injection of strychnia into the affected muscles.
>
> There is an important distinction between contraction and contracture. In the latter instance, local pressure induces reflex spasm and division of the contracted parts will be required.
>
> Lateral curvature of the spine is in most instances caused by unbalanced muscular action, particularly of the serratus magnus. Even in advanced cases the bodies of the vertebrae retain their normal shape.
>
> Knock knees are caused by muscular weakness and contraction. In severe cases division of the shortened tissues and of the biceps tendon is indicated as a preliminary to traction, to correct the deformity. Osteotomy is not mentioned.

The greater part of the book, like those of Davis and Knight, is concerned with chronic diseases of the joints (tuberculosis), the basic treatment being the constant traction of Davis, supplemented by operative intervention, more radical than is considered advisable at the present day.

The operation, described and illustrated at great length and detail, is a subperiosteal resection of the hip joint, designed to permit a reproduction of the resected bone and restoration of function. This type of

operation, now discarded, and the plaster jacket, still in use, were evidently considered his chief contributions to surgical progress.

The lectures make entertaining reading at the present time, and must have been most impressive to those who listened to them. They suggest natural enthusiasm unhampered by exact knowledge, and stimulated, doubtless, by the contrast between the effects of his own positive treatment and what was essentially neglect. It would appear, furthermore, that his actual treatment was often more reasonable than the theory which was improvised to explain it, and which he evidently regarded as of secondary importance. For he cautions his students, "Never be governed by the *ipse dixit* of any man unless the demonstration accompanying it, or your own careful investigation, shall convince you that the principles enunciated are true".

Sayre's book reflects the quality of the writer and particularly what the essayist calls personal influence. One of his former house officers at Bellevue Hospital records his impressions as follows: "Lewis Albert Sayre had a wonderful personality; he was of powerful build and had a keen, searching eye; his unflagging enthusiasm for his work, his interest in the house staff and patients, inspired confidence and aroused a like enthusiasm in those who came in contact with him. His enthusiasm knew no bounds when he was speaking of his success in treating spinal diseases with the plaster jacket, or late stages of hip disease by excision of the hip joint. He was a wonderful teacher of orthopaedic surgery; in fact orthopaedic surgery as a specialty began with his teaching. He took as much interest in teaching his house staff in the wards as he did the students in the amphitheatre. Those who knew him only superficially were apt to consider him rough; he was blunt of speech and made no pretence to diplomacy, but those who saw him at close range knew there was a warm and tender side to his heart".

He was, in the retrospective estimation of a contemporary, "a really big man. He had little learning of any kind and was consequently unhampered in any undertaking by the knowledge of the failures of others. He never devised any of the things attributed to him, but he knew a good thing when he saw it, adopted it and claimed it as his own. Thus he popularized many useful things, which otherwise would not have been known. He knew himself for what he was, a good advertiser, able to learn from his own failures".

Of these inventions or adaptations which range from a tracheotomy tube to a scrotal clamp, showing the scope of his activities, none can now be identified except the plaster jacket.

Sayre, like Taylor, had in early life an illuminating experience. His preceptor was the Professor of Surgery in the Medical School, and Sayre was much impressed by his lecture on abscess. One of the patients had an abscess about the knee which Sayre proceeded to open. When he reported the result, the professor called him a "damned blockhead". "For," said he, "my lecture was on hot abscess. This was a cold abscess,

and you've killed the man". "But", said Sayre, "he didn't die. He got well, and I never believed anything that any of them told me after that."

Yet, Sayre's teaching, as illustrated by the extracts quoted, reminds one of the conclusion of Artemas Ward that "it's better not to know so much than to know so many things that ain't so".

It will appear from this review that the group of pioneers by no means presented a united front in the campaign of progress.

Sayre was regarded by the conservatives as an arrogant and mendacious exponent of "adventurous treatment". He had an equally critical and more emphatically expressed opinion of their professional shortcomings, both individually and collectively.

Davis had a comprehensive grievance against all the others, particularly Taylor, "for robbing him of his discoveries", and Taylor's opinion of Davis' mechanical ability has already been quoted. The three irreconcilables were in accord on but one point, namely,—that Knight, in discarding traction, was a therapeutic derelict.

There was also another and far more radical distinction between them,—Sayre considered himself a surgeon and included Clinical Surgery in his professional title. The other members of the group represented a development of the ancient practice of mechanical treatment with individual variations. This development is clearly presented by Bradford [11] in a memorial to Taylor. He states that at this time surgeons paid little attention to detail, but left the fitting of appliances to brace makers. Consequently, patients were supplied with supports that did not support, protection apparatus that did not protect, and traction apparatus that did not pull. "Thoroughness was Dr. Taylor's best quality, and added to this was an extraordinary self-reliance and enthusiasm which attracted patients and led them to persist during the long years that were necessary for cure under the direction of a masterful intelligence."

At this time little was known of the influence of function on structure, and the moral and physical burden of brace-wearing for months or years was considered of little moment if eventually deformity might be corrected, even in part, by so called conservative treatment.

Orthopaedic Surgery was haled by Mott as a new era in the healing art because, in combining surgery with mechanics, it greatly increased the effectiveness of each.

It is apparent, from the examination of the meager fare which these text-books offered to the student of the period, that the great advances in scope and method that have established Orthopaedic Surgery have been made since Dr. Shaffer's essay was written. It is further apparent that the dominant influence in this progress has been the surgical factor of the combination which Mott haled as foreshadowing a new era in the healing art. It follows, therefore, that Sayre alone of the pioneers can present a valid claim to fatherhood of American Orthopaedic Surgery, since he was the only one who practised it, and thus held the door open to progress.

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KINETICS OF HUMAN GAIT

The Making and Interpretation of Electrobasographic Records of Gait

The Influence of Rate of Walking and the Height of Shoe Heel on Duration of Weight-Bearing on the Osseous Tripod of the Respective Feet*†

BY R. PLATO SCHWARTZ, M.D., ARTHUR L. HEATH, WILLIAM MISIEK, M.A., AND JOHN N. WRIGHT, ROCHESTER, NEW YORK

Pathology which produces evidence of abnormalities in gait may be found in patients treated by any branch of medicine. This is the result of the dependence of "normal" gait upon the interrelationship of the normal function and coordination of the major systems,—(1) the cerebral cortex, motor, sensory, and sympathetic nerves, (2) voluntary and involuntary muscle coordination, (3) osteo-articular structures, and (4) the cardio-vascular system.

Interest in the therapeutic advantage to be gained by recording human gait is, therefore, not confined to the restricted field of orthopaedic surgery.

The complexity of the phenomena of gait transcends visual analysis. One or more components of gait must be selected for recording and the interpretation of records. Two years ago we directed our attention to the sequence of weight-bearing on the osseous tripod of the respective feet. This has been referred to in terms of the heel, fifth metatarsal head, and the great toe of each foot.

One year ago evidence indicated that the "Pneumographic Method of Recording Gait" [1] could be made to reveal the sequence, the duration of weight-bearing, and the pressure applied with respect to these three points of support. Although useful from an academic point of view, this method presented many complications. We were unable to adapt it to the simplicity of clinical requirements most essential for application to the improvement of the treatment of patients.

Sequence and duration of weight-bearing on the three respective points of each foot seemed to be the most important phenomena to be recorded. Our premise is: *Any alteration of normal pressure on one or more of these three points will necessarily be accompanied by a change in the normal sequence or duration of time spent on the other points of the respective feet.* At present we need additional evidence for the absolute acceptance of this statement. We believe there may be exceptions; with such ad-

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mission the above premise becomes the foundation for the "Electrobasographic Method of Recording Human Gait."

The electrobasographic record measures gait in terms of:

1. The duration of weight-bearing on each foot.
2. The time spent on the heel, the fifth metatarsal head, and the first toe of each foot.
3. The time interval in which weight is received on each of these three points.
4. The time interval in which weight is delivered from each of these three points.
5. The time interval between the reception of weight on the right heel and the reception of weight on the left heel.
6. The time interval between the reception of weight on the left heel and the reception of weight on the right heel.
7. The rate of walking,—*i. e.*, the number of steps per second.

Such records are made by using the electrobasograph in the following manner. A 100-foot roll of No. 1 Eastman News Bromide, single weight, glossy, normal, photographic paper, seventy millimeters wide, is enclosed in a camera box (Fig. 1). The paper is driven at constant speed by a direct-current motor and gear reducer past a horizontal slit in the front of the camera box, out through a horizontal slit in the back, to be wound on the take-up spool (Fig. 2). Seven electric lights are so arranged in the light box that light from each lamp passes through separate openings in the anterior slit on to the moving photographic paper.

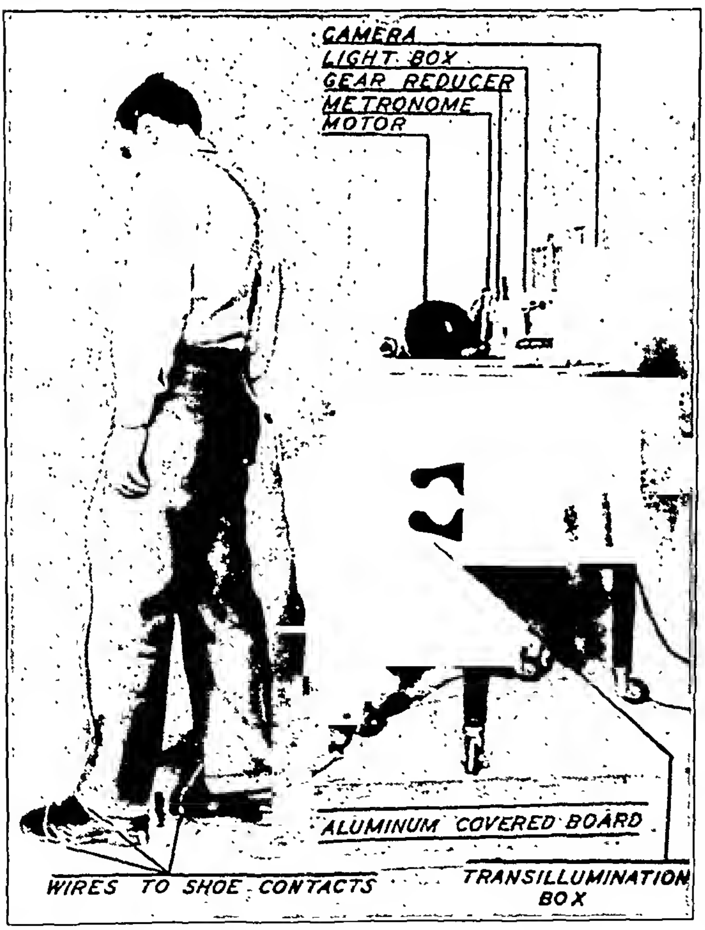

Fig. 1

A patient, standing with contacts on his own shoes, ready to make an electrobasographic record while walking on a metallic surface.

Three electric lights represent the heel, fifth metatarsal head, and the great toe of the right foot; three other lights represent the correspond-

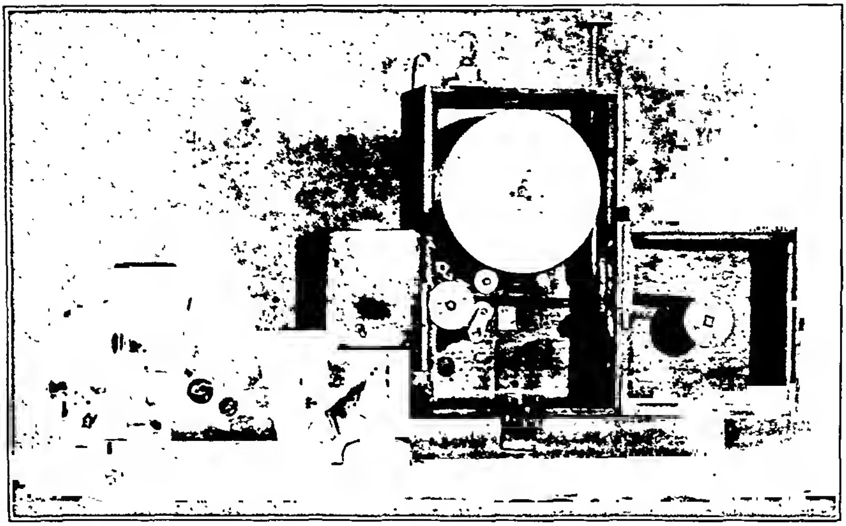

FIG. 2

The electrobasograph. Parts named from left to right,—direct-current motor, metronome, light box, open camera box, take-up reel.

ing points on the left foot. The seventh light is connected with the metronome which records time in seconds (Fig. 1 and Fig. 2).

Brass contacts are placed on the soles of the patient's shoes (Fig. 1 and Fig. 3). The patient walks on a metal surface (Fig. 1). The shoe contacts and metallic surface are the respective sides of a direct-current circuit. These three points on each shoe act as switches which are alternately opened and closed when the patient walks, thus activating the lights in the recording mechanism.

The correct placement of the contacts is assured by palpation of the respective bony landmarks. The correct wiring to respective lamps in the light box is checked by the transillumination box (Fig. 1 and Fig. 4).

An electrobasographic record of normal gait is explained in Figure 6. It is apparent that the records correspond to "electrical footprints" which provide for the seven mathematical determinations previously stated.

FIG. 3

Three-quarter-inch circular contacts on man's shoe, half-inch on woman's and boy's shoes, held in place by heated flake shellae.

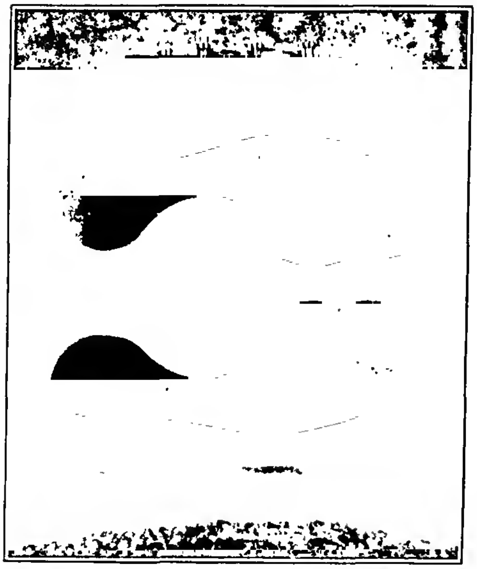

FIG. 4

The transillumination box, showing illumination resulting from contact of the right first toe, the left heel, and head of the fifth metatarsal.

Validity of the method must include proof that the records made on successive dates will be the same, so long as the patient's gait remains unaltered. Such proof is presented in Figure 7, which reveals weight-bearing on the left fifth metatarsal head following medial proximal displacement of the left scaphoid (Fig. 5). Proof of the converse is available in Figure 8.

The influence of the rate of walking on the electrobasographic records is revealed in the graphs of three different normal subjects (Fig. 9 and Fig. 10). This evidence indicates that, as the rate increases, the duration of weight-bearing on the three respective points of each foot diminishes in a straight line.

Much comment has been made with regard to the height of heels on women's shoes. The seven different shoes, illustrated in Figure 11, were worn by one normal girl. The records indicate an increasing instability of the foot, most evident in the shoe with heel height of three and one-eighth inches, and more evident on the right foot than on the left.

The graphs (Fig. 12) show that the duration of "normal" weight-bearing increased for heel and first toe of each foot, slightly diminished for left fifth metatarsal, and lessened with an abrupt drop when the height of heel exceeded two and one-half inches. These data partially explain the observation that during weight-bearing, pronation and instability of the feet are increased with increasing heel height which favors pivoting.

FIG. 5

Anterior-posterior and lateral views of left foot illustrating medial dislocation of scaphoid on astragalus, resulting in equinovarus deformity.

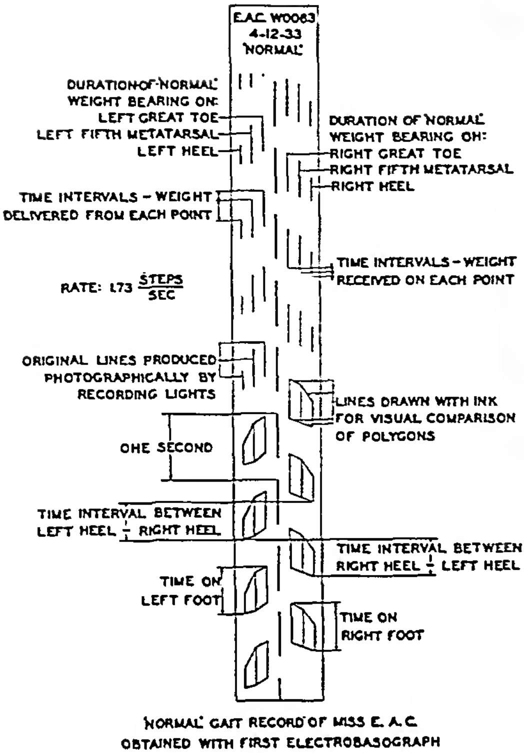

Fig. 6

Interpretation of an electrobasographic record of "normal" gait.

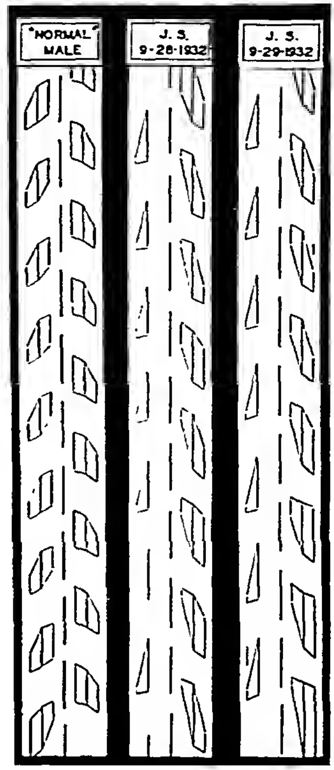

Fig. 7

Electrobasographic record of "normal" man at left. Second record, J. S., aged sixty-four; traumatic medial dislocation of scaphoid on astragalus. The second and third records are duplicates, although they were made on successive dates. Weight-bearing almost entirely on left fifth metatarsal head.

SUMMARY

1. The electrobasograph is briefly described as an instrument for recording the gait of man.

2. Important time relationships can be determined from these records which are made with relation to the duration of weight-bearing on the heel, fifth metatarsal head, and first toe of the respective feet.

3. Illustration of records provides evidence that unaltered gait will produce the same records on successive dates.

4. Illustration of records provides evidence that the removal of the cause for a limp will be revealed by changes in the electrobasographic record on successive dates.

5. Graphs are presented to illustrate the influence of the rate of walking on the duration of weight-bearing on each of these three points.

6. Records and graphs illustrate the influence of height of shoe heel on the duration of weight-bearing on each of these three points.

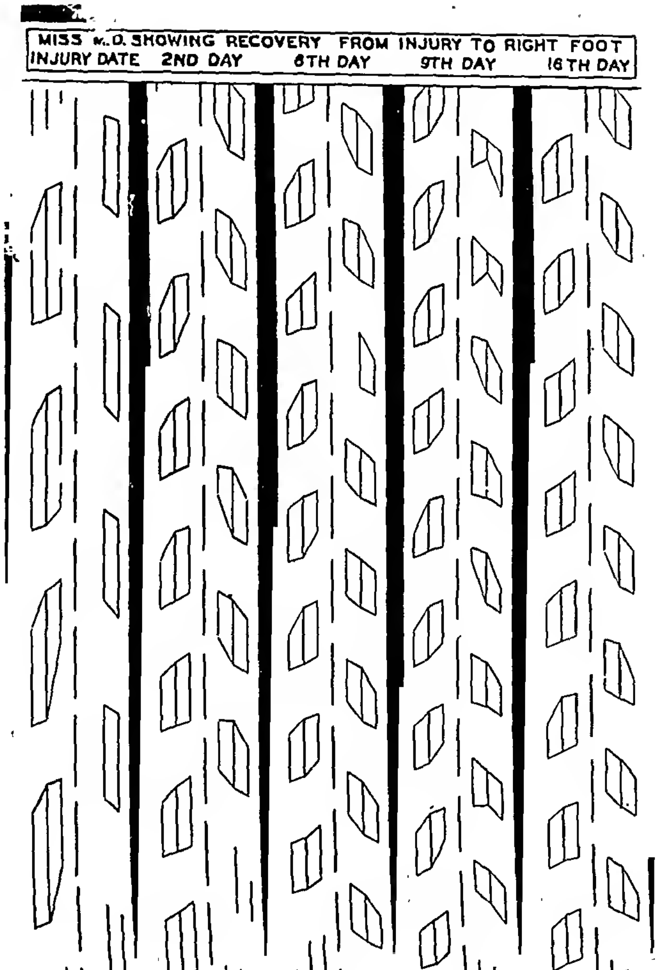

FIG. 8

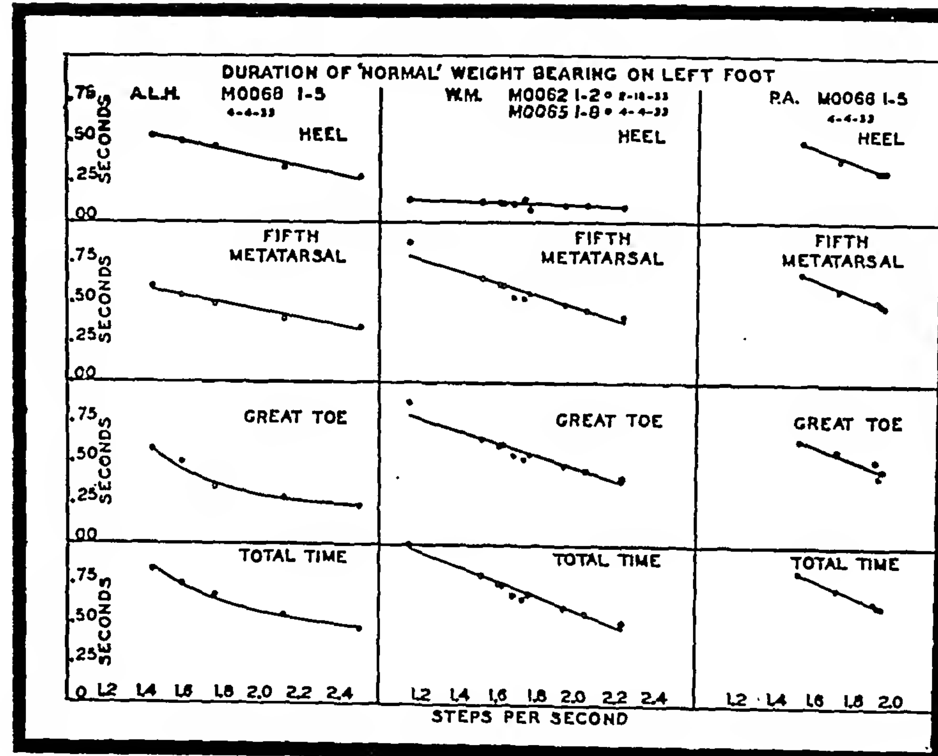

FIG. 9

Graphic evidence of diminished duration of weight-bearing on the left heel, fifth metatarsal, and great toe with increased rate of walking. Three different normal subjects.

FIG. 8

Gait records of Miss D., aged thirty-three; uncomplicated trauma of second toe of right foot. Injured October 18, 1932. Last record, sixteen days after injury, reveals normal gait in the absence of subjective symptoms of physical signs of injury.

Fig. 8 (*Continued*)

	Duration of Weight-Bearing		Rate
	Right Foot	*Left Foot*	
Oct. 18, 1932.	1.3 seconds	1.8 seconds	0.89 steps per second
Nov. 3, 1932.	0.80 seconds	0.79 seconds	1.56 steps per second

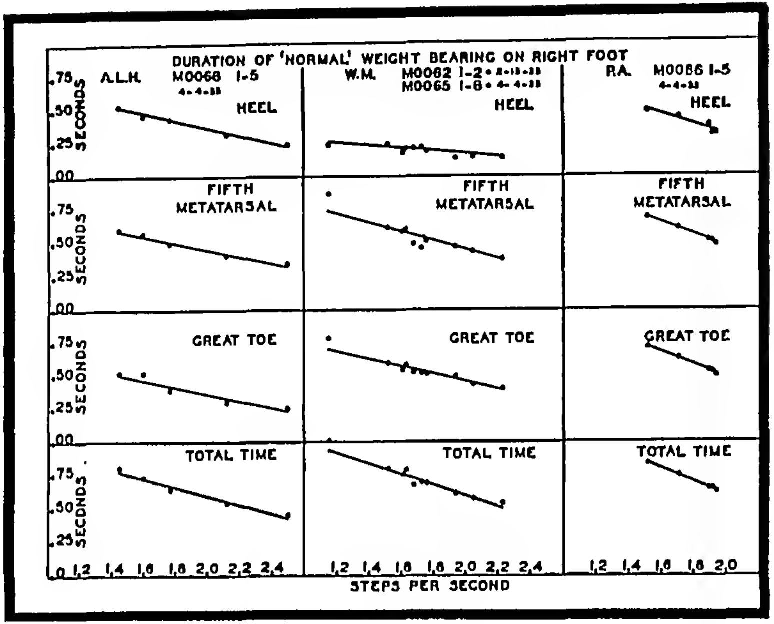

Fig. 10

Graphic evidence of diminished duration of weight-bearing on the right heel, fifth metatarsal, and great toe with increased rate of walking. Three different normal subjects, as in Fig. 9.

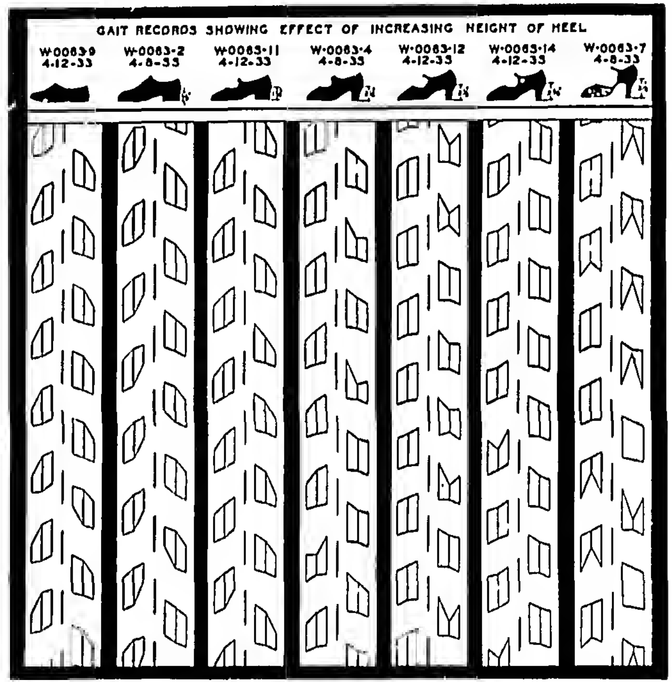

Fig. 11

Fig. 11

Seven electrobasographic records of the same normal girl. Shoes varied in heel height from 0 to $3\frac{1}{8}$ inches. Note electrobasographic evidence of altered weight-bearing time on fifth metatarsal head, most evident in last record of right foot.

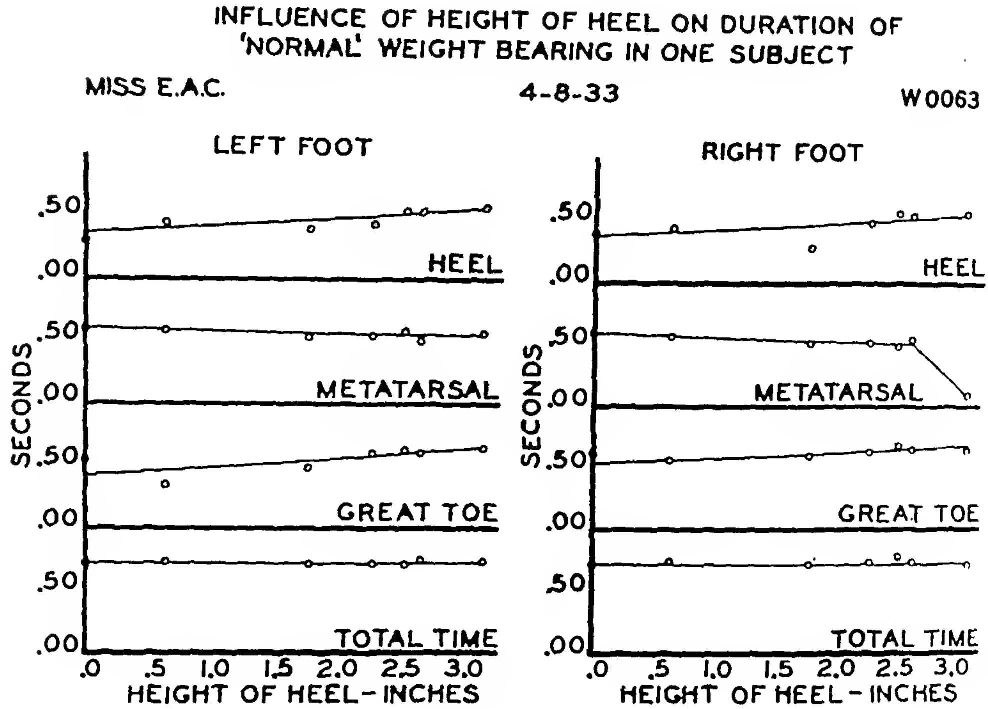

FIG. 12

Graphic evidence of: (1) increased weight-bearing time on heel and great toe with increasing height of shoe heel; (2) diminution in weight-bearing time on fifth metatarsal head, most evident on the right foot after shoe heel exceeded 2.5 inches in height.

ACKNOWLEDGMENT

It is gratifying to again enumerate those to whom we are indebted for the privilege of presenting these data pertaining to the kinetics of human gait:

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Appreciation is again expressed for the time and materials graciously donated to our advantage by Mr. Harry Gordon of the Rochester Telephone Corporation.

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PERIOSTITIS OF THE OS CALCIS

BY C. C. CHANG, M.D., AND LEO J. MILTNER, M.D., PEIPING, CHINA

From the Division of Orthopaedic Surgery, Department of Surgery, Peiping Union Medical College, Peiping, China

Periostitis of the os calcis is a fairly common chronic, disabling disease, occurring usually among adults. It is characterized by a deposition of lime or a proliferation of bone on the surface of the os calcis, chiefly near the sites of origin of the plantar fascia and the insertion of the Achilles tendon. Most frequently the process remains localized in those regions, but in advanced cases it may extend so as to involve all of the surfaces of the posterior portion of the bone.

The following etiological factors have been described: (1) gonorrhea; (2) trauma; (3) arthritis; (4) foci of infection bearing streptococcus; (5) metabolic disturbances; (6) syphilis; (7) arteriosclerosis, tuberculosis; and (8) neurotrophic disturbances. According to most observers, infection and trauma are of primary significance. When infection is the chief etiological factor, either the gonococcus or the streptococcus may be present. Trauma plays a definite part in every case, although infection of one type or another may initiate the disease.

Pathology:

In the early stages of the condition, the periosteum shows signs of low-grade chronic inflammation as evidenced by thickening and oedema, proliferation of fibroblasts, and round-cell infiltration. Later on, lime salts are deposited beneath the periosteum and also outside of it, especially near the points of insertion of the fascia and tendon. As the condition progresses, new bone may be formed in these places. In the most advanced cases, microscopic examination of sections of bone shows fibrosis of the marrow tissues, small areas of necrosis, hyaline or gelatinous degeneration and, at places, proliferation of fibroblasts and sclerosis of the cortical bone. Periostitis and osteitis, occurring secondary to bursitis, show essentially the same findings (Fig. 1-A and Fig. 1-B).

Symptoms:

The most important symptoms are pain and tenderness over the affected area. As a rule, the onset is gradual with pain only during walking or standing. The pain may be sharp or dull, constant or intermittent, depending on the type and activity of the periostitis. The small, sharply defined spur is apt to cause piercing pain, while the more extensive periostitis is associated with dull, aching pain. Swelling is often seen in the advanced case, located especially over the inflamed area. In the arthritic case, the swelling of the subcutaneous tissues is often more diffuse.

Owing to constant attempts on the part of the patient to shift the body

Fig. 1-A
Roentgenogram of an os calcis, showing a mild periostitis with calcification above the region of insertion of the tendo achillis. The periostitis is secondary to an inflammation of the deep Achilles bursa.

Fig. 1-B
Photograph of heels of the case shown in Fig. 1-A. On the left heel, note the soft-tissue swelling (bursitis), both posterior and lateral to the insertion of the tendo achillis. The normal right heel is shown for comparison.

weight away from the painful heel, the normal body mechanics may be disturbed so that metatarsalgia, pain in the ankles, knees, and lower back frequently are associated symptoms.

Diagnosis:

With the aid of roentgenograms, it is possible to determine accurately the area of involvement and the stage of development of the periostitis. Roentgenograms offer the only sure method of differentiating this condition from arthritis, arch strain, osteoma, and lesions of the medullary portion of the bone. Periostitis of the os calcis occurs only rarely during adolescence, and

FIG. 2-A

Roentgenogram of an os calcis, showing the most common type of spur formation at the medial origin of the plantar fascia from the inner tubercle of the os calcis.

then it should not be confused with apophysitis which is an involvement of the posterior inferior epiphysis. In the latter disease, roentgenograms show irregularity, clouding, and obliteration of the cartilage plate.

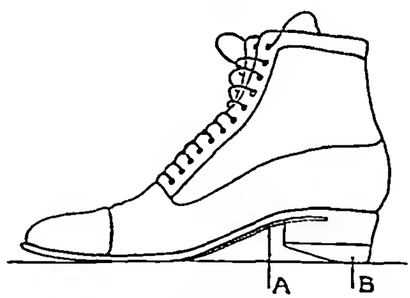

FIG. 2-B

Drawing of shoe corrections (Steindler method) used to relieve the pain from a spur such as is shown in Fig. 2-A. Note the metal arch (*A*) and the wedge-shaped elevation of the heel (*B*) which transfers the site of pressure posteriorly to the uninvolved surface of the os calcis.

Treatment:

Conservative treatment should be given a fair trial in every case before the operative removal of the spur is recommended. Non-operative treatment consists chiefly in attempts to eliminate the etiological factors, and in the institution of rest and local applications to relieve the pain. Whenever possible, foci of infection in the teeth, tonsils, sinuses, gastro-intestinal and genito-urinary tracts should be eradicated. In practically every instance, the avoidance of weight-bearing affords decided relief from the painful symptoms. While the patient is at rest, hot applications may be used. Complete local rest may be secured by the application of plaster-of-Paris casts over the feet and lower legs. The casts may be maintained in position from

FIG. 3-A

Roentgenogram showing a more advanced type of periostitis with spur formation involving the entire inferior weight-bearing surface of the os calcis. In the writers' series, most of the cases showed advanced periostitis similar to that illustrated in this figure.

FIG. 3-B

The same os calcis as shown in Fig. 3-A, one and one-half years after operative treatment which afforded ninety per cent. relief from pain.

Fig. 4-A

Roentgenogram of an os calcis, showing extensive periostitis and superficial osteitis which involves the inferior, superior, and, to a lesser extent, the lateral surfaces of the os calcis.

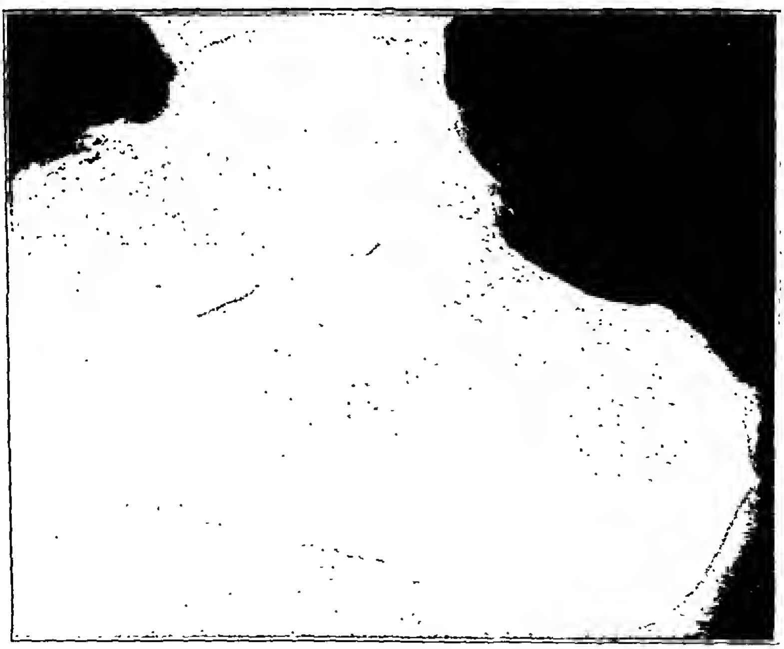

Fig. 4-B

The same os calcis shown in Fig. 4-A, one and one-half years after operative treatment. Although a slight recurrence of the periostitis is present, the patient has almost complete relief from pain.

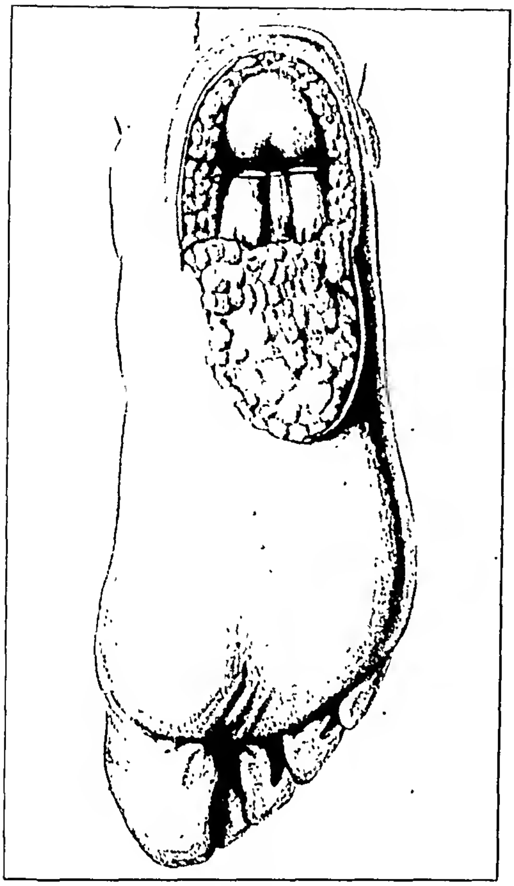

FIG. 5
For inferior spurs, a transverse incision is made through the plantar fascia just anterior to the tubercles of the os calcis.

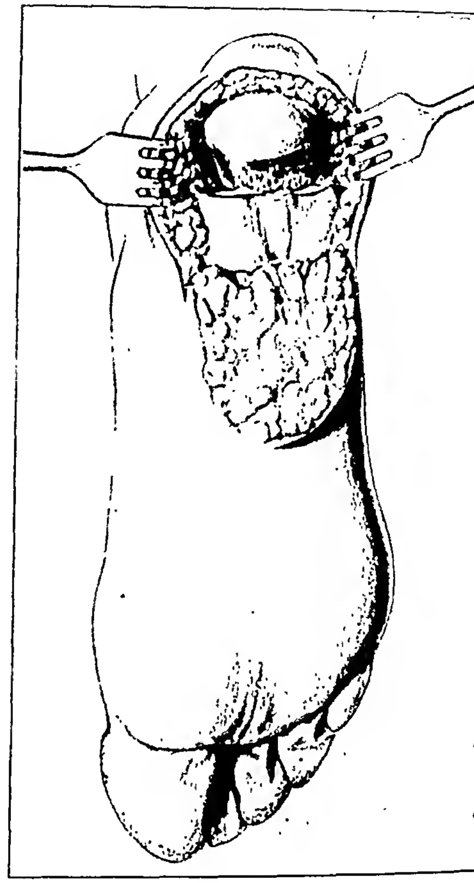

FIG. 6
For simple inferior spurs, removal of the origin of the plantar fascia and the tubercles of the os calcis is performed.

one to four weeks, depending upon the severity of the symptoms. Oftentimes this period of rest affords complete relief which may persist for many months. Immediately following the removal of the plaster-of-Paris casts, corrections should be applied to the shoes and the patient instructed to use crutches for several days. If the spur is located in a small circumscribed area near the origin of the plantar fascia (Fig. 2-A), very satisfactory relief may be obtained by the use of a special heel (Fig. 2-B). In addition, the shoe should be fitted with a rigid shank, so as to prevent lowering of the long arches. With this heel, practically all of the weight is transmitted posteriorly to the uninvolved portion of the os calcis. When the entire inferior weight-bearing surface of the os calcis is tender, a soft rubber sponge placed inside of the shoe at the heel may afford a great deal of comfort. The sponge should be thinner in the center than at its margins so that more of the weight will be carried on the lateral margins of the heel. When the periostitis is located only near the region of the insertion of the tendo achillis, it may be advisable to increase the height of the heel of the shoe by approximately one-fourth of an inch or more. This elevation relaxes the tendon to a certain extent, and thereby decreases the amount of strain on the inflamed area. In the case of the prominent

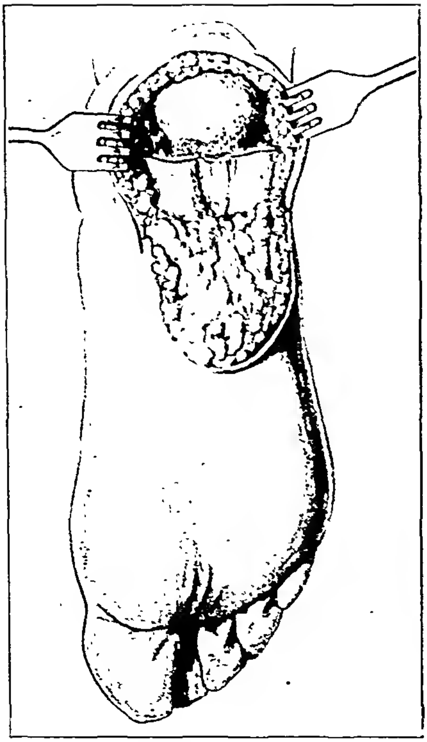

FIG. 7
If the periostitis involves the entire inferior weight-bearing surface of the os calcis (Fig. 3-A), the whole area is denuded.

FIG. 8
Drawing to illustrate the exposure gained by the goblet incision. This approach is used for the most advanced cases of periostitis of the inferior, superior, and lateral surfaces of the os calcis (Fig. 4-A).

heel, as described by Roth, it may be necessary to build special shoes which will conform more nearly to the unusual shape of the posterior portion of the os calcis. Since many of the cases of painful heel are associated with flat feet, it is very important to institute the proper treatment for this condition. In a high percentage of the early cases, shoe corrections, properly applied, will afford partial relief of pain for an indefinite period of time, so that immobilization by means of casts is necessary only in the few persistent cases.

In the treatment of spurs, Liberson and Pokorny have claimed excellent results following the use of deep x-ray therapy.

Operative treatment is reserved for those advanced cases which fail to respond to the various conservative methods. The horizontal incision (Steindler), the J-shaped incision, or the U-shaped incision (Griffith) may be used to expose the inferior surface of the os calcis. Either incision may be extended up along the medial or lateral edge of the tendo achillis, so as to expose the posterior and superior surfaces of the os calcis. In our hands the most satisfactory approach has been obtained through the U-shaped or the goblet incision.

The steps of the operation as used in this Clinic are described as follows: For inferior spurs, a flap consisting of skin and subcutaneous tissue is reflected anteriorly, and a transverse tenotomy of the plantar fascia (Fig. 5) is made just distal to the tubercles of the os calcis. By means of an osteotome, the involved bone and periosteum are removed, and the surface of the bone is made smooth (Fig. 6). If the entire inferior weight-bearing surface is involved (Fig. 3-A and Fig. 3-B), it should be denuded and a smooth surface prepared as illustrated in Figure 7. For

TABLE I

Results of Operative Treatment: Total Number of Operations—35

Most Important Etiological Factor *	No. of Operations	Method of Operation: Excision	Method of Operation: Excision and Implantation of Fascia	Result: Good A	Result: Good B	Result: Fair A	Result: Fair B	Result: Poor A	Result: Poor B	Incomplete Follow-up	Recurrence A	Recurrence B
Trauma......	7	A		2		2					1	
			B		2		1					1
Gonorrhea....	5	A				1				2		
			B				2					2
Arthritis......	13	A		2		4		2			2	
			B		2		1		2			3
Foci of infection	7	A		2		2					1	
			B		1		2					1
Cause undetermined	3	A		1								
mined........			B		2							
		A		7		9		2		2	4	
Total.........	35		B		7		6		2			7
Percentage....				40		42.9		11.4		5.7	31.4	

* Not infrequently several etiological factors were present in the same case. In this table is listed only that factor which is assumed to be of primary importance.

periostitis of the inferior and posterior portions of the os calcis, a goblet incision is used (Fig. 8). All of the involved periosteum is removed, following which the superficial surface of the underlying cortical bone is chiselled away. At the same time, the Achilles bursa is resected. In an occasional case, the periosteum on the posterolateral surfaces of the os calcis is involved; hence, those areas of bone also are denuded and made smooth (Fig. 8). Following the closure of the wound, plaster-of-Paris casts are applied over the foot and leg and maintained in position for at least three weeks. From seven to ten days after the operation, windows

are cut in the casts for the purpose of removing the stitches. Following the removal of the casts, the patient is kept at partial rest for a period of three weeks. During this time physiotherapeutic treatments are given and the patient is allowed gradually to resume weight-bearing with the aid of crutches.

In an effort to prevent the recurrence of exostoses postoperatively, an alternative operation was used. This operation consisted of excision of the involved periosteum and soft tissues and covering the exposed surface of bone with fascia lata.

Statistics:

During the past eleven years, thirty patients have been treated for periostitis of the os calcis. Conservative treatment was given a fair trial in all cases but, *since the periostitis was advanced in most instances*, only fifteen patients received satisfactory relief from their symptoms. Thirty-five operations were performed upon the twenty cases (in five the condition was unilateral and in fifteen bilateral). The results of the operative treatment are classified as good, fair, and poor. The term "good result" signifies apparent cure with complete relief from symptoms; "fair result" indicates approximately seventy-five per cent. of relief from pain; and "poor result" indicates little or no improvement. Table I shows good results following fourteen operations (40 per cent.), fair results following fifteen operations (42.9 per cent.), and poor results following four operations (11.4 per cent.).

TABLE II

RESULTS OF SIMPLE EXCISION OF PERIOSTEUM AND SPUR COMPARED WITH EXCISION PLUS THE IMPLANTATION OF FASCIA

Method of Operation	No. of Operations	Results					
		Good		Fair		Poor	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
One side—Excision alone	9	5	56	2	22	2	22
Opposite side—Excision and implantation of fascia lata....	9	4	45	3	33	2	22

After operation, thirty-one and four-tenths per cent. of the cases showed roentgenographic evidence of recurrence of spur or of extension of the periostitis (Fig. 4-A and Fig. 4-B).

A fairly accurate evaluation of the merits of the combined procedure of excision and fascia implantation was made in a study of nine of the cases. In these cases approximately the same amount of periostitis was present on both sides and the pain was of about the same degree. On one side, simple denudation of the os calcis was performed: on the other side

the same procedure was carried out, and, in addition, transplants of fascia lata were placed over the denuded surface of the bone. A study of the end results in these nine cases shows approximately the same percentage of good and fair results after each method of operation. These findings (Table II), therefore, do not warrant the addition of the latter procedure to the standard operation.

SUMMARY

A review of the etiology, pathology, diagnosis, and treatment of periostitis of the os calcis is given, and the results of operative treatment in a group of cases of very severe periostitis are presented.

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THE EFFECT OF SYMPATHECTOMY AND OF VENOUS STASIS ON BONE REPAIR

An Experimental Study *

BY PAUL E. MCMASTER, M.D., LOS ANGELES, CALIFORNIA AND
NORMAN W. ROOME, M.D., CHICAGO, ILLINOIS

From the Department of Surgery of the University of Chicago

The following experimental studies were made to determine what influence lumbar sympathectomy and venous stasis exert on bone repair. A small series of experiments dealing with the influence of femoral-artery ligation and sciatic-nerve section on bone healing are also included.

I. EFFECT OF LUMBAR SYMPATHECTOMY ON BONE REPAIR

How does sympathectomy influence bone repair? Colp and Mage[1], studying clinical cases, did periarterial sympathectomies in recent fractures and in fractures with delayed union, and stated that union was more rapid in these cases as compared to a control series. Leriche[2], in 1927, concluded from a series of eleven cases and from a survey of the literature that periarterial sympathectomy seemed indicated: in cases of delayed union of fractures when the cause is not syphilis, in secondary resorption of callus, in recurrent fractures, and in pseudarthrosis.

Various observers (Bacq[3], Cannon and co-workers[4], Bisgard[5]) have found that sympathectomy has no stimulating effect on bone growth in young experimental animals. Harris[6], however, concluded from a number of cases that it is possible by lumbar sympathectomy to accelerate the rate of growth in a child's leg shortened by anterior poliomyelitis. Bisgard[5] failed to confirm this observation by studies on a half-grown monkey with open epiphyses and symmetrical residual paralysis of both lower extremities from experimental anterior poliomyelitis.

Palma[7] and Fontaine[8] studied the influence of sympathectomy on bone repair in experimental animals and reported more rapid healing of the fractures in the sympathectomized limbs. Pearse and Morton[9], and Key and Moore[10], however, concluded from their experimental work on animals that the sympathetic nervous system has a very slight or no effect in hastening osteogenesis.

Experimental Work:

Because of these conflicting views as to the influence of the sympathetic nervous system on bone growth and bone repair, the following experimental studies were made, a preliminary report of which has been published[11]. Immediately following a left lumbar sympathectomy which

* Received for publication, August 7, 1933.

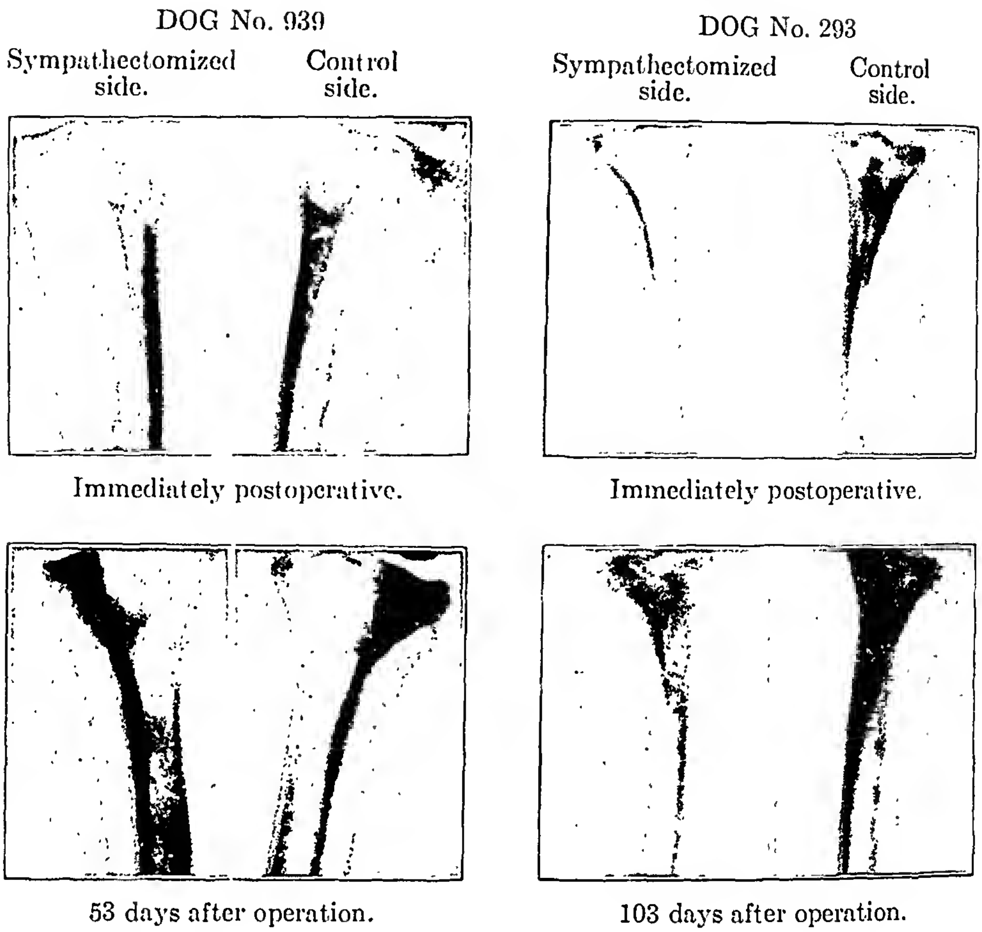

FIG. 1

The upper four roentgenograms show the amount of bone removed subperiosteally at the time of sympathectomy. The lower pictures show the more rapid healing of the non-sympathectomized sides. Healing was complete on both sides approximately three weeks after the lower pictures were taken.

included at least three and usually four ganglia and the intervening chain from the sacral promontory upward, equal segments, approximately one and five-tenths millimeters in length, were resected subperiosteally from near the upper end of the fibulae in nineteen dogs, after the method of Pearse and Morton[9]. In a second series of ten dogs, following the sympathectomy, a simple osteotomy was done at the upper end of each fibula. The fibulae were chosen as they are not essential to weight-bearing; hence splints or casts are not required. The animals had the usual freedom of the laboratory.

Healing was studied by roentgenograms and was considered complete when bony callus had completely bridged the gap between the bone ends. In the first group, in which fibular segments had been removed, the wounds remained free from infection in twelve experiments, while seven dogs were discarded because of infection. Six of the twelve dogs presented the unexpected finding of bilateral absorption of the ends of the fragments of the fibulae, although the same technique had been employed in these dogs as in those in which bony repair of the defect occurred.

There was at no time any evidence of infection to complicate the picture and the skin wounds healed promptly. Bone absorption at both ends of the fibular defect is continuing to take place six to sixteen months postoperatively, without any apparent attempt at healing, and the original defects of one and five-tenths millimeters have increased in length to five to ten millimeters. Further studies are being made of this condition.

Complete bony healing occurred in four of the twelve dogs, the average time required being twelve weeks. In each there was more rapid healing on the non-sympathectomized side by an average of two to three weeks (Fig. 1). One dog died of pneumonia seven weeks after operation. At the time of death there was more bony callus on the non-sympathectomized side, although the bony defect was not completely healed.

Fibular fragments were excised from another dog in which a left lumbar sympathectomy had been done six months previously. The defects were repaired after seventy-four days; no difference was noted in the healing time between the sympathectomized and the control sides.

DOG No. 836

Sympathectomized side. Control side.

Three weeks after operation.

Four months after operation.

Fig. 2

The upper two roentgenograms were taken three weeks after simple osteotomy of the fibula, and show some bone absorption at the fracture sites. The lower pictures show complete bridging of the bone defect on the non-sympathectomized side: the sympathectomized side is not completely healed.

In the second group of ten experiments in which simple osteotomies of the fibulae were performed, four dogs were discarded because of wound infections. Three died from distemper thirty-one, thirty-three, and fifty-three days, respectively, after operation. At the time of death there was no essential difference in the amount of bony callus present on the sympathectomized and control sides in any of the three. One of the remaining three dogs showed definitely a more rapid healing on the non-sympathectomized side at the end of four months when compared to the opposite side (Fig. 2), while in two dogs the fibulae were equally and

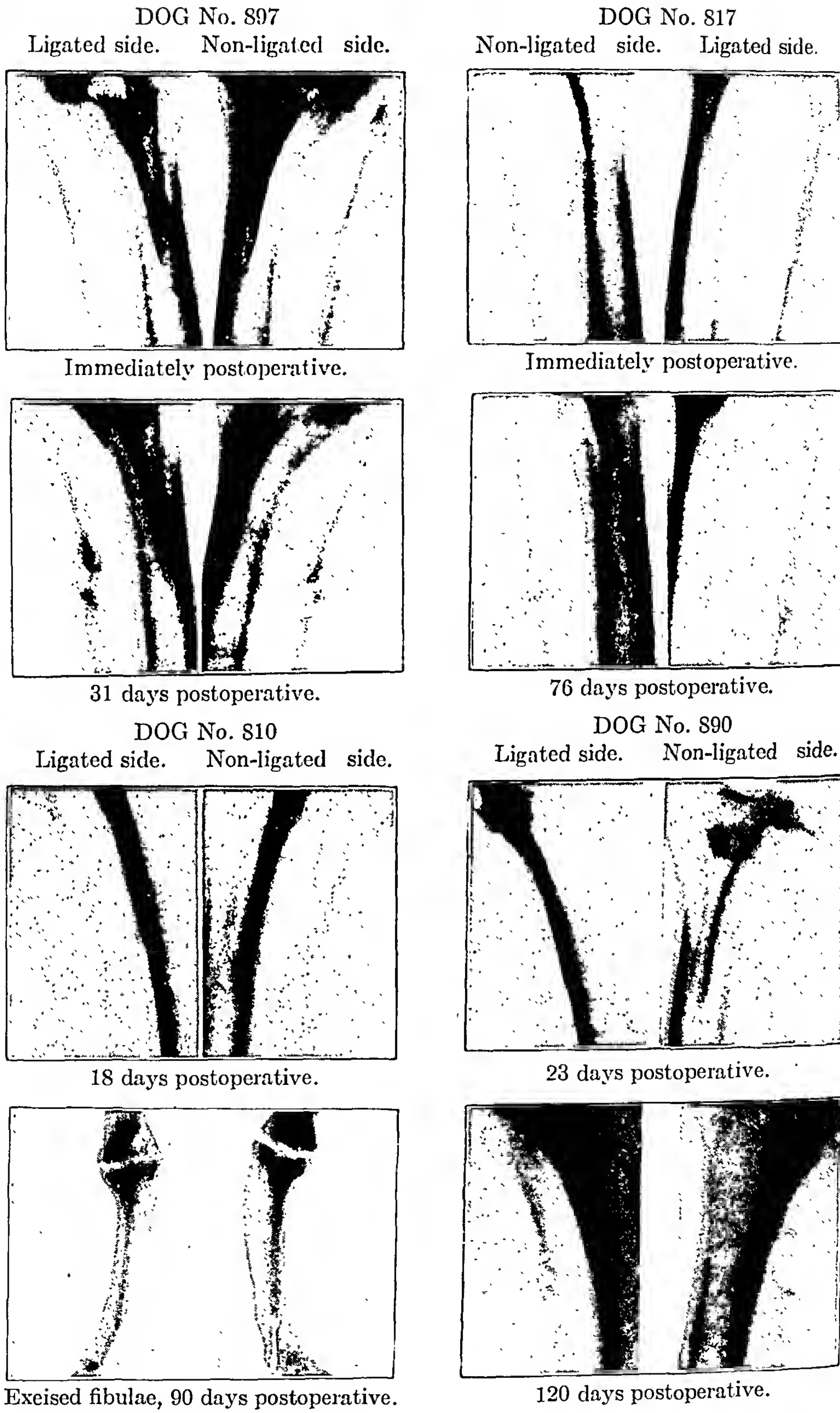

FIG. 3

Roentgenograms showing the amounts of bone removed at operation in four animals, and the effect of venous ligations on the healing of the defects. There was more rapid healing on the ligated side in all four cases; in the fifth case of this series the defects healed simultaneously.

completely healed at sixty-eight and eighty days, respectively, after operation.

2. EFFECT OF VENOUS STASIS ON BONE REPAIR

Pearse and Morton[12] have reported that bone healing proceeds more rapidly in the presence of venous stasis.

In the present experiments eleven dogs were used to determine the effect of venous stasis on bone repair. In each, the femoral vein on one side was isolated in the upper thigh and sectioned between ligatures, proximally to the large circumflex branches. In five dogs segments, each approximately one and five-tenths millimeters in length, were then resected subperiosteally from near the upper end of each fibula. In the other six animals simple osteotomies were done near the upper end of each fibula. Some of the dogs showed a marked oedema on the ligated side, while in others only slight, if any, oedema resulted. Splints or casts were not used. Healing was determined by roentgenograms and considered complete when bony callus had entirely bridged the defect.

Three of the animals in which segments had been removed exhibited absorption of the fragment ends as previously mentioned. Of the other two, one showed equal healing of the two sides after eighty days; while in the second there was more rapid healing on the ligated side which was complete sixty-four days after operation; healing on the non-ligated side occurred two weeks later. One of the six dogs on which simple osteotomies were done died of distemper too soon after operation to give positive information. Of the remaining five, four showed more rapid healing on the ligated side (Fig. 3). The average period on this side was seventy-nine days. Healing on the non-ligated side in this group required from two to four weeks longer. The fifth showed healing of the bone defect on each side fifty-one days after operation.

3. EFFECT OF NERVE SECTION AND OF ARTERIAL LIGATION ON BONE REPAIR

In three dogs the left sciatic nerve was sectioned in the proximal portion of the thigh and equal segments were then removed subperiosteally from near the upper end of each fibula. None of these showed any difference in the healing time of the two sides.

The femoral artery on the right side in one dog, and that on the left side in another, was isolated in the proximal thigh and sectioned between two ligatures. Following this, simple osteotomies were done at the upper end of each fibula. In both dogs healing was equal on the two sides. From previous experimental observations after ligation of the femoral artery in dogs, it has been noted that there is a rapid establishment of collateral circulation in the thigh; therefore, no effect on bone repair was to be expected from this procedure.

DISCUSSION

Experiences have shown, both clinically and experimentally, that more pronounced and more lasting effects—such as increased warmth and dryness of the skin—result from ganglionectomy than from periarterial sympathectomy. Yet, with the increased arterial hyperaemia resulting from lumbar sympathectomy, this procedure did not hasten the repair of bone in the experiments described. In half of the uncomplicated experiments here mentioned, healing was actually retarded, when compared to the non-sympathectomized side. The results of these experiments, as well as those of Pearse and Morton[9], and Key and Moore[10], cast doubt on the advisability of doing any type of sympathectomy in an attempt to hasten bone repair in clinical cases.

Harris [6] listed the following clinical conditions which have caused an increased longitudinal growth in the affected limbs of children: synovial tuberculosis, hemangioma of the leg, Brodie's abscess of the upper end of the tibia, giant-cell tumor of the tibia, femoral and iliac thrombosis, recurring hemarthrosis of the knee from hemophilia, chronic osteomyelitis of the femur, severe trauma to soft parts with resultant and prolonged infection and ulceration, and fracture of the femur. The results of our experiments, in which venous stasis hastened the repair of bone, confirm similar observations made by Pearse and Morton [12]. In the diseases just listed, as well as in the experimental work, there are all stages of congestion from a sluggish circulation to a marked venous stasis. Hence it appears that bones grow more rapidly and heal more promptly in the presence of venous congestion. Following lumbar sympathectomy, there is present an arterial hyperaemia with an increased blood flow and no venous stasis or sluggishness of circulation; consequently, this procedure would not be expected to have the same stimulating influence on bone growth or repair as venous ligation.

CONCLUSIONS

1. Experimental lumbar sympathectomy in dogs did not hasten bone repair; in the majority of cases bone healing was retarded.
2. Experimental venous stasis in dogs hastened bone repair.

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A METHOD FOR THE INTERNAL FIXATION OF TRANSCERVICAL FRACTURES OF THE FEMUR *†

BY H. HEYWARD WESCOTT, M.D., F.A.C.S., ROANOKE, VIRGINIA

The internal fixation of transcervical fractures of the femur is possible through a small incision over the lateral aspect of the femur. With the Smith-Petersen nail as the fixing instrument, the total operating time is from six to fifteen minutes. The operation produces a minimum amount of shock and allows immediate active use of the joint, preventing the usual complications expected from a prolonged period of fixation and recumbency. The details of the procedure, together with a résumé of the first twelve cases, follow.

DETAILS OF THE PROCEDURE

Immediately following admission to the hospital, a Buck's extension is applied to prevent muscle spasm and overriding of fragments, and to lessen shock. Following a short period of rest, the forward angle, or

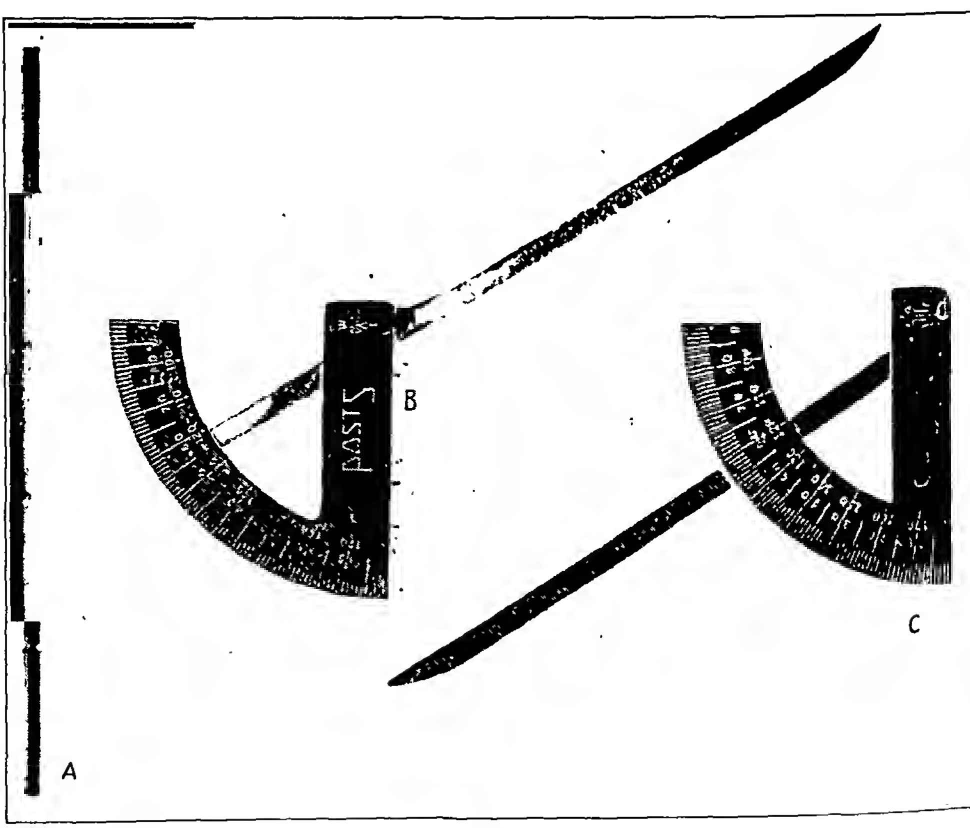

Fig. 1

A. Measuring rod. *B*. Roentgenogram protractor. *C*. Bone protractor.

* Received for publication, August 10, 1933.

† This paper, with report of eighteen cases, was presented at the meeting of the American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 9, 1934.

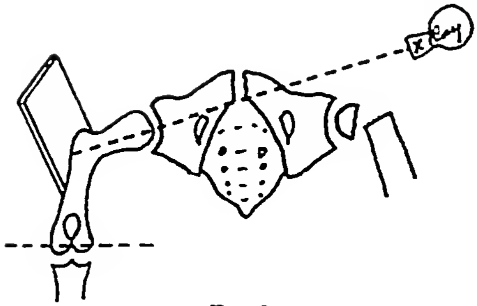

FIG. 2

Position of cassette and roentgen-ray tube in relation to the normal hip, to determine the degree of anterior torsion.

FIG. 3

Roentgenogram showing head superimposed on trochanter, with degree of angulation of tube noted on film.

FIG. 3

angle of anteversion is determined with a portable x-ray machine in the patient's room. The tube of the x-ray machine is placed on the side of the fractured hip with the focal point directed toward the center of the normal hip. A cassette is held in place against the normal hip at right angles to the rays of the tube (Fig. 2). Several roentgenograms are made, imprinting on each negative, with lead numerals, the angle made between the roentgen rays and a line through the lower condyles of the femur. The number on the negative showing the head superimposed on the trochanter denotes the forward angle (Fig. 3). This is the number of degrees the condyles or femoral shaft must be internally rotated to flatten the neck (Fig. 4). The forward angle has been found to vary from five to thirty degrees in different individuals. The angles, however, are the same on the two sides in each individual, unless there has previously existed some disease or injury to one of the hips.

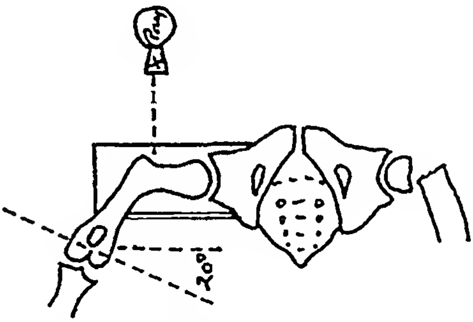

FIG. 4

The normal hip internally rotated twenty degrees to flatten the neck.

The exact length of the nail necessary to transfix the fragments should be ascertained as soon as the forward angle is determined. An x-ray film is placed under the normal hip (Fig. 4). (To make the film lie flat, the sagging of the bed should be corrected by boards if necessary.) The tube is then centered over the hip, and the femur internally rotated the required number of degrees to correct the forward angle. The measuring rod (Fig. 1 and Fig. 5) is strapped with adhesive to the trochanter; a negative

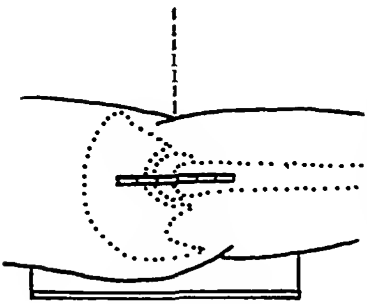

FIG. 5

Side view of Fig. 4, showing measuring rod strapped against trochanter.

is made (Fig. 6). The distance from a to b is superimposed over the rod shadow c to d, and the exact length of the nail necessary to fix the fragments is determined. The nail is then made for the individual case.

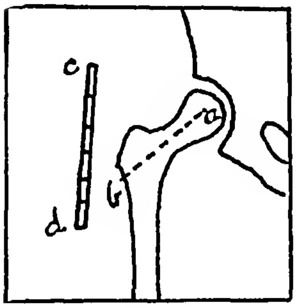

FIG. 6

Roentgenogram of Figs. 4 and 5, showing shadow of hip and of measuring rod. Line a–b superimposed over measuring rod determines the length of the nail.

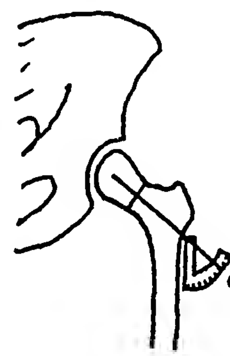

FIG. 7

Roentgenogram protractor superimposed over roentgenogram of fractured hip after reduction, to determine angle of neck with shaft. Reading is made at c.

It is to be remembered that, while the point of the blades must penetrate the proximal fragment deep enough to give stability without encroaching upon the cartilage, the head of the nail should extend one-fourth of an inch beyond the cortex to make easy the extraction of the nail at a later date. The line a–b should, therefore, extend outside the cortex of the shaft of the femur for about one-fourth of an inch.

Twenty-four to forty-eight hours later, without releasing the pull of the Buck's extension, the patient is removed to the operating room.

Operation: A flat Bucky diaphragm or tunnel is placed under the fractured hip and the x-ray tube is centered over the hip. The Bucky diaphragm or tunnel makes possible the taking of stereoscopic roentgenograms and the changing of plates without the necessity of lifting the patient for the insertion of each film. Under a suitable anaesthetic, the Buck's extension is removed and the fracture is reduced by internally rotating the femur and gently flexing it at the hip two to three times. While flexing the thigh, sufficient traction is made to counterbalance the weight of the thigh. After this manipulation, the leg is extended in internal rotation. No abduction is necessary, as it may produce a valgus deformity. An assistant then holds the femur internally rotated the number of degrees required to correct the forward angle, until the operation is completed. Stereoscopic roentgenograms are made to prove reduction. If reduction is complete, an incision, two and one-half to three inches long, is made over and below the trochanter.

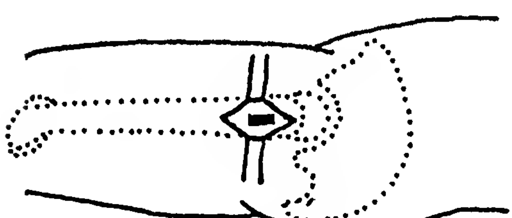

FIG. 8

Small incision over trochanter. Nail started.

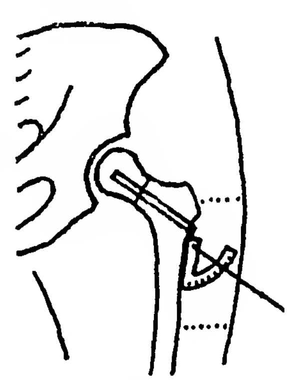

FIG. 9

Bone protractor against shaft. Lever set at the same degree as determined in Fig. 7. Nail inserted in line with the lever of the bone protractor.

One-half inch below the vastus muscle, a small hole is bored into the bone and, with an osteotome, narrow slits are made to receive the blades of the nail (Fig. 8). The roentgenogram protractor (Fig. 1, *b*) is placed over the roentgenogram taken after reduction, with its base along the shaft, one-half inch below the vastus muscle, and the lever is made to correspond with the center of the neck (Fig. 7). The reading of the number of degrees of angulation of the neck with the shaft is made at *c* and the bone protractor is set at a like angle and clamped. The nail is driven into the flattened neck at the angle indicated by the lever of the bone protractor (Fig. 9). The fracture is impacted and the wound is closed. Stereoscopic roentgenograms may be made if desired to check the course of the nail.

The twelve cases herein reported constitute the total number of fractured hips admitted to the hospital within a period of one year. The end results in three more recent cases will be included in a later report. The method of fixation, as described, was used in each case irrespective of age or general condition. In spite of the fact that several of the patients were poor surgical risks, there were no deaths that could be attributed to the operation or its after-effects. No added external fixation was applied except in Case 12, in which case a Buck's extension was used for four weeks because of the marked comminution and fragmentation of the bone. Though internal fixation is contra-indicated in intratrochanteric fractures, it was used in Case 6. The patient's physical and mental condition was such that external fixation and inactivity would not have been tolerated. All other cases were allowed immediate free active use of the leg without weight-bearing. A wheel chair was used within twenty-four to forty-eight hours after the operation, and crutches were allowed after a few days, except in those cases showing a marked senile dementia or general weakness.

In Table I "Motions, normal" means a full range of motion as compared to the normal hip. "Normal gait" means the complete restoration of function and the impossibility of being able to distinguish between the fractured and the normal hip by seeing the patient walk.

In explanation of the poor results as shown in Table I, the following notes are included:

Case 2. Bed-ridden, fell from bed, received transcervical fracture four months prior to operation. Operation to relieve pain and muscle spasm.

Case 3. Marked senile dementia. Continued to walk against advice after fixation. Second operation: nail and bone graft. Limited internal rotation. Walks with limp.

Case 6. Intratrochanteric fracture. Condition would allow no other means of fixation.

Case 8. Bed-ridden for eighteen months. Thoroughly septic from large decubitus over sacrum. Fixation to allow turning in bed. Died ten days after operation from sepsis.

TABLE I

REVIEW OF CASES

Case	Sex and Age	Condition	Accident	Operation	Crutches	Weight-Bearing	Motions	Shortening	Gait
1	M. 51	Poor	Feb. 18, 1932	Feb. 20, 1932	3rd day	7 weeks	Normal	None	Normal
2*	F. 82	Poor, bed-ridden	Dec. 29, 1931	Mar. 26, 1932					Died 2 mos. later
3*	M. 59	Poor, car-diorenal. Senile dementia	Apr. 23, 1932	May 2, 1932 Sept. 11, 1932	14th day	1 day 9 months	Normal Limited	Nail bent, 1 inch	Uses cane
4	F. 74	Broken compensa-tion	June 10, 1932	June 13, 1932	5th day	3 months	Normal	½ inch	Normal
5	F. 75	Good	June 14, 1932	June 17, 1932	3rd day	3 months	Normal	None	Normal
6*	F. 62	Poor, car-diorenal	July 13, 1932	July 15, 1932	45th day	3 months	Normal	1 inch	Normal
7	F. 59	Fair	July 7, 1932	July 8, 1932	8th day	2 months	Normal	None	Normal
8*	F. 62	Poor, bed-ridden	Aug. 6, 1932	Aug. 16, 1932					Died, 10th day
9	F. 52	Good	Aug. 19, 1932	Aug. 25, 1932	5th day	2 months	Normal	None	Normal
10*	F. 62	Poor, car-diorenal	Nov. 20, 1932	Nov. 23, 1932 Dec. 12, 1932					Non-union
11	F. 58	Poor, car-diorenal	Jan. 21, 1933	Jan. 25, 1933	10th day	3 months	Normal	None	Normal
12*	F. 51	Good	Feb. 7, 1933	Feb. 13, 1933	30th day	6 months	Normal	None	Normal

* For further details about these cases, see case notes on pages 375 and 378.

FIG. 10

Case 9. After insertion of nail and impaction of fragments.

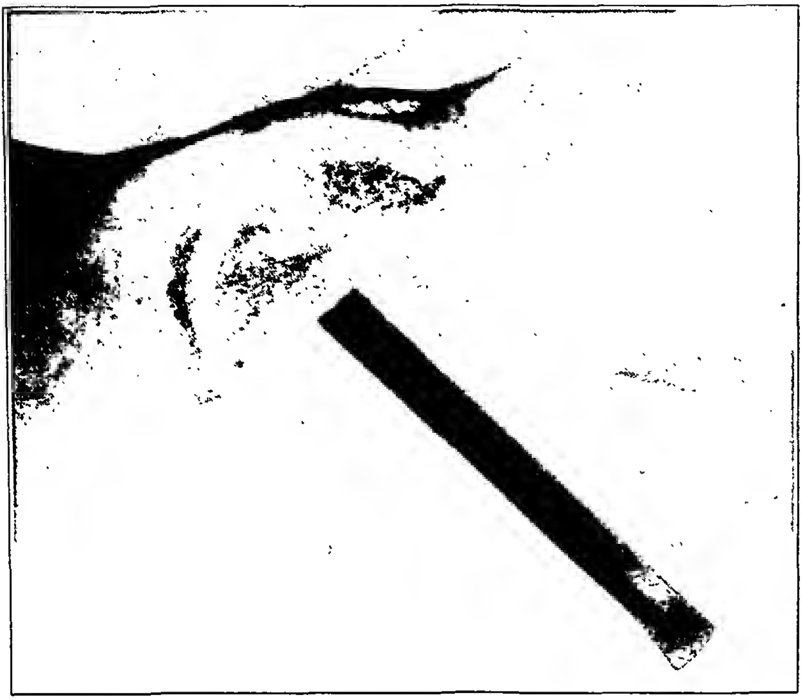

FIG. 11

Case 9. Two months later. Note firm bony union, shortening of neck, and protrusion of nail head beyond cortex.

Case 10. Marked senile dementia. Blood pressure 280. Against advice, attendants allowed patient to walk on fifth day after each operation, disrupting fragments.

Case 12. Marked comminution of femoral neck necessitated a longer period of rest in bed and delayed weight-bearing.

CONCLUSIONS

1. Recent transcervical fractures of the femur may be reduced and transfixed by a surgical procedure requiring six to fifteen minutes.
2. The shock of a major operation is eliminated.
3. External fixation is unnecessary.
4. After but a few hours the patient is ready for a wheel chair or, if so disposed, may at once enjoy the use of crutches.

FRACTURES OF THE RADIUS AND ULNA. A NEW ANATOMICAL METHOD OF TREATMENT * †

BY ROGER ANDERSON, M.D., F.A.C.S., SEATTLE, WASHINGTON

The complex anatomy of the forearm has previously interfered with reduction and end results of fractures of both bones of the forearm; but, when these same obstructing parts are approached physiologically, they become fundamental to the support of a new fracture therapy. The basic principle of this new anatomical method of treatment is a specialized form of double skeletal transfixion, operated in conjunction with a miniature fracture table, by which agencies reduction and immobilization are automatically obtained. Open operation is routinely advocated by many authorities; but, even after surgical reposition, the final reduction and function are often far from satisfactory. We believe, therefore, that this method, a closed procedure, is a decided step toward our ideal of fracture treatment,—maximum function in minimum time.

Under previous modes of treatment, the wide range of joint hypermobility of the normal forearm augmented the difficulties of immobilization, and the small size and structure of the bones were also a source of fracture difficulty. As the ulna is the larger bone of the upper forearm, it is the main osseous segment, while the reverse is true at the wrist. The fact that the radius alone articulates at the true wrist joint and projects beyond the ulna has important clinical significance (Fig. 1). The interosseous space is at its maximum width in supination, while in full pronation the radius nearly contacts the ulna (Fig. 1). Cognizance of this will prevent misinterpretation of the check-up films. It seems rather inexplicable that other skeletal methods omitted consideration of the well known fact that in rotation the radius alone moves, while the ulna remains stationary.

Coordination of normal anatomical function with mechanical manipulation is the basis of this closed technique which does not depend on the usual skeletal traction but on a specialized form of double transfixion. The proximal insertion through the ulna supplies both counterextension and fixation. Hence, it becomes not only the direct means for fixing the ulna, but indirectly, through the strong interosseous membrane and the orbicular ligaments, it is also the agent of immobilization for the upper radial fragment (Fig. 1); while, correspondingly, the distal half-pin, although transfixing only the radius, also holds the lower ulnar fragment through the articular disc, the interosseous membrane, and the ligaments of the radio-ulnar joint.

Partial transfixion at the wrist is the key factor in restoring anatomical relationships and preserving physiological function. To meet these specifications and to obtain supination, traction, and immobilization

* Read before the Annual Meeting of the Pacific Northwest Orthopaedic Society, Portland, Oregon, September 16, 1933.
† Received for publication, August 23, 1933.

a special half-pin has been devised (Fig. 6-*p*). This pin is short-tapered but sharp-pointed to permit passage by hand pressure alone. It is fashioned with two squared flanges or collars, the inner flange placed so that the depth of insertion into the radius may be correctly gauged, the outer flange forming a buttress which, when placed against the horseshoe, insures anatomical rotation. The collars are square in shape, so that

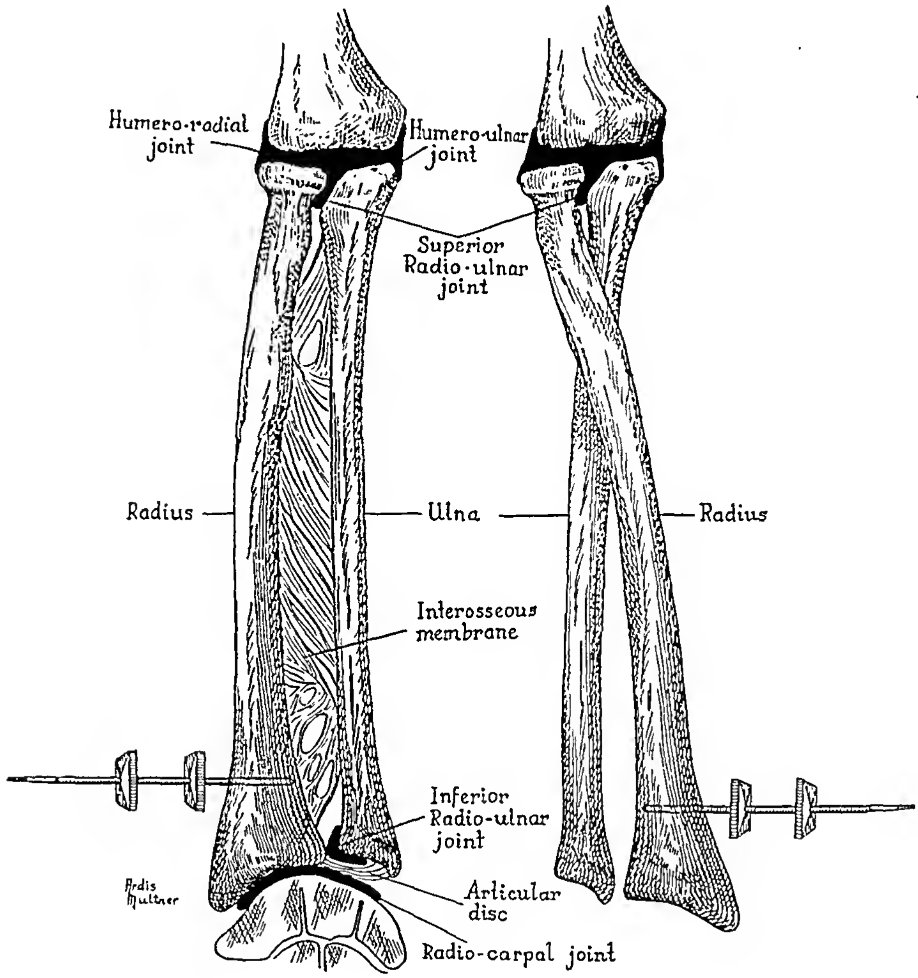

Fig. 1-A

Anterior view of right forearm in supination. Note width of interosseous space, also elongation of radius at the wrist.

Fig. 1-B

Same view in pronation, with consequent transposition of half-pin from the lateral to the medial side.

when they are incorporated in the cast the half-pin can neither move nor turn. Furthermore, sidewise slipping of the radius on the half-pin is rendered impossible by the use of a flexible aluminum cuff, U-shaped in order to slip over the distal end of the forearm from the ulnar side (Fig. 6-*g*). The cuff is fastened to the horseshoe by a removable stud pin.

DESCRIPTION OF FRACTURE TABLETTE

Reduction is practically obtained automatically with a small apparatus, a miniature fracture table, which aligns the fragments mechanically,

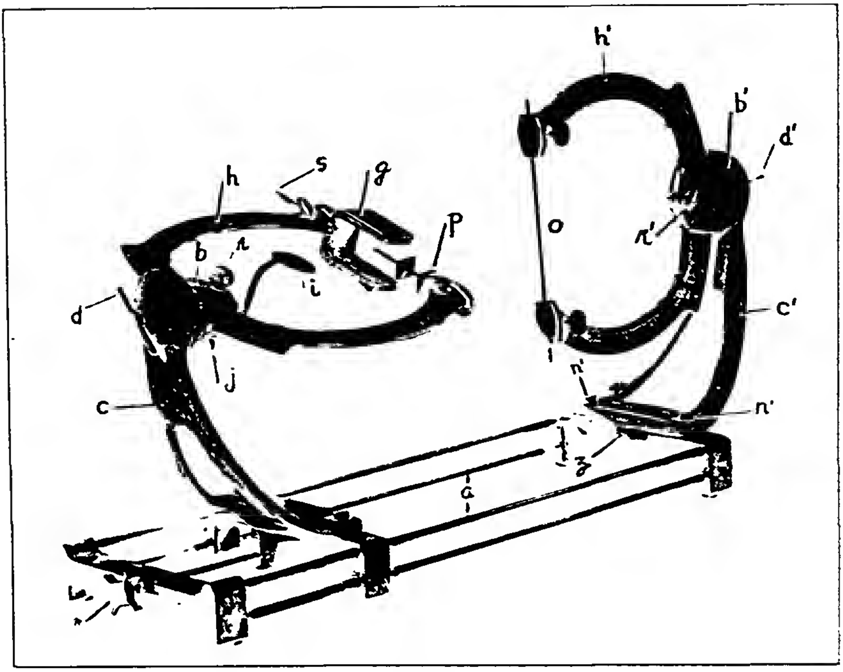

Fig. 2
The automatic splint.

a. Duraluminum frame.
b–b′. Horseshoe bases, source of rotating and sidewise movement.
c. Sliding end bracket.
c′. Stationary end bracket.
d–d′. Rotation lock nuts.
f. Traction rod handle.
g. Rubber-lined aluminum cuff.
h–h′. Aluminum horseshoes.
i. Adjustable hand rest.
j. Hand-rest nut.
n′. Bracket bolts by which single standard base is attached.
o. Ulnar transfixion.
p. Half-pin.
r–r′. Sidewise lock nuts.
s. Stud pin.
z. Hole drilled in frame into which horseshoe bases can be fitted for use in fractures of the leg.

while permanent retention is maintained by incorporating the pins. This reduction device, only twenty-four inches long, is constructed of aluminum (Fig. 2). Thumb nuts (*d–d′*) lock the horseshoes in any degree of rotation, nuts (*r–r′*) hold the fragments in either adduction or abduction, while the traction nut (*f*) provides traction. The hand rest (*i*) is adjustable and easily removable later from the cast. To facilitate tilting and also fluoroscopic

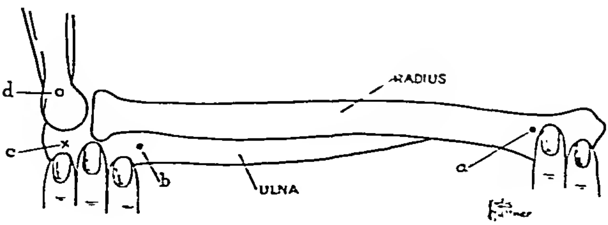

Fig. 3
Lateral view of right forearm in supination, depicting points of transfixion: *a.* Site for insertion of half-pin in radius; *b.* Proximal insertion of ulna; *c.* Site for third pin when complicated with a fracture of the olecranon; *d.* Transfixion point of humerus for the unusual case.

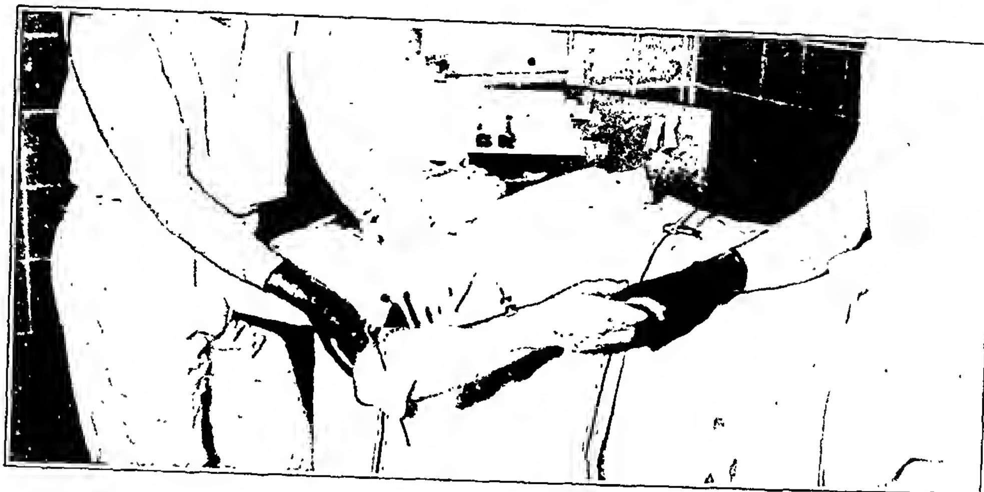

Fig. 4-A

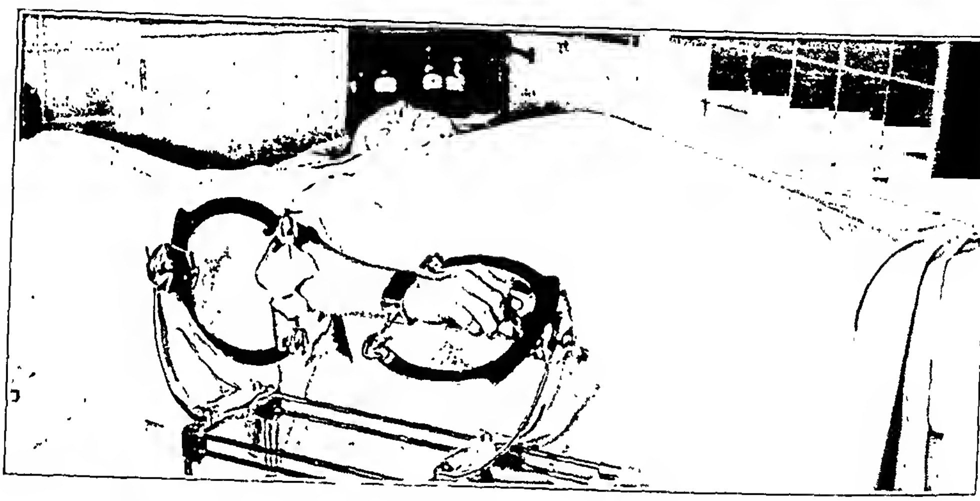

Fig. 4-B

Fig. 4-C

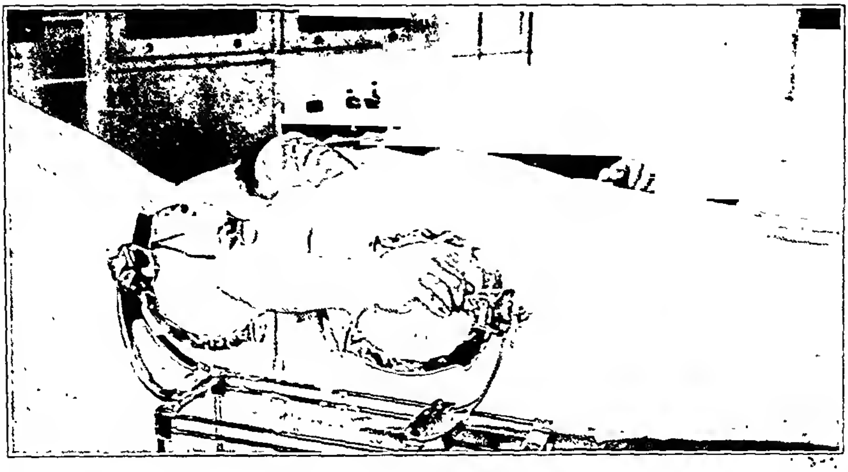

Fig. 4-D

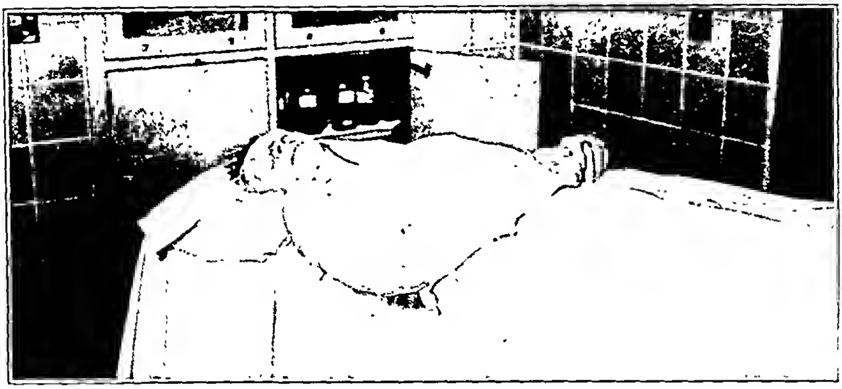

Fig. 4-E

Steps in routine reduction.

Fig. 4-A. Double transfixion.
Fig. 4-B. Placement of forearm in splint.
Fig. 4-C. Application of upper segment of cast followed by manipulation and x-ray examination.
Fig. 4-D. Completion of circular cast, incorporating half-pin.
Fig. 4-E. Removal of casted arm from splint and further covering of pin ends.

examination a single standard base has been substituted for the legs formerly used.

Every effort has been made to perfect a practical apparatus. The long traction screw rod and a more slender half-pin make it possible to use the same apparatus for children. Horseshoes of different material or width may be substituted, at the same time preserving the mechanical rotation, full 360 degrees, on the identical normal axial line. By removal of the end brackets, the frame is convertible into an automatic splint for leg fractures. As only durable and rustless metals are used in its construction, the whole apparatus may be sterilized in the autoclave.

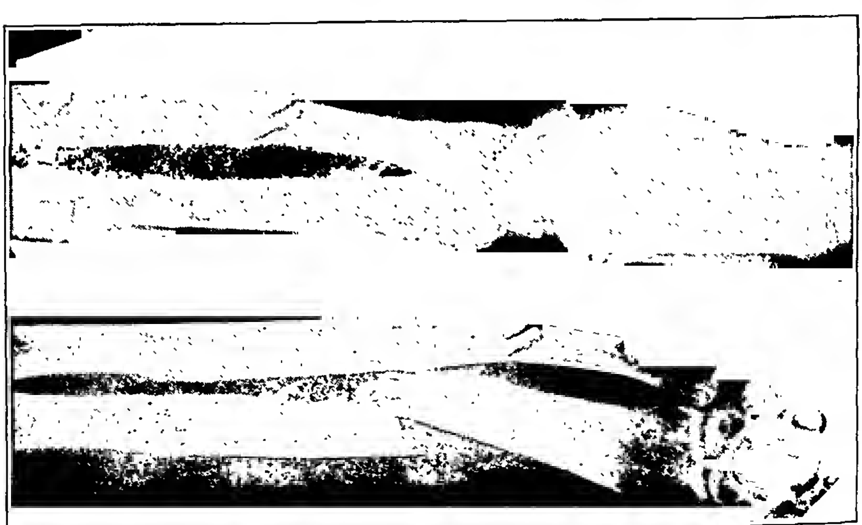

Fig. 5-A

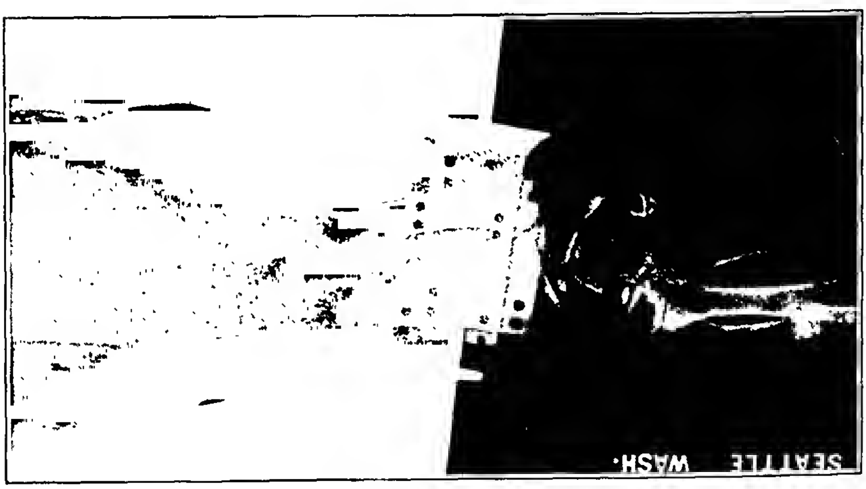

Fig. 5-B

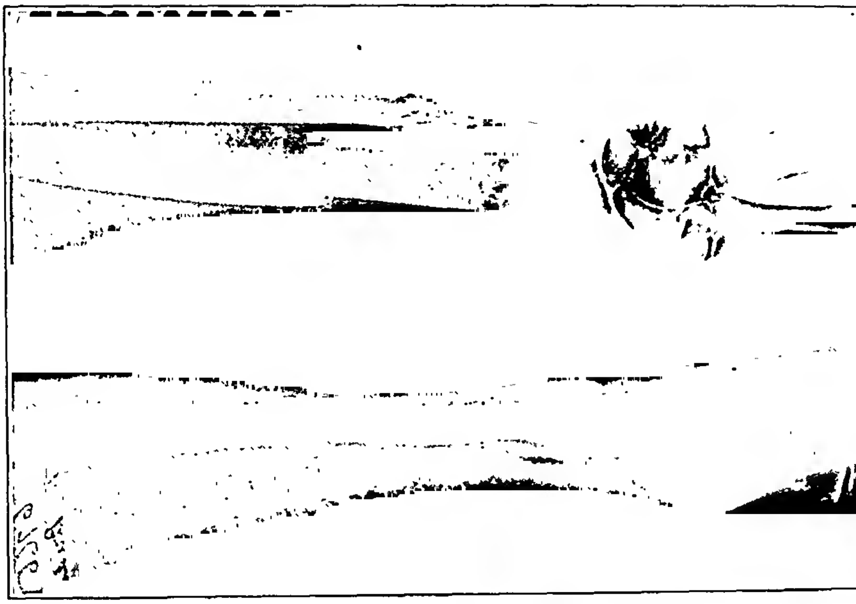

Fig. 5-C

Mrs. E. B., aged sixty-five years. Fracture of both bones of the forearm complicated by an extensive compound wound.

Fig. 5-A. Before treatment. Fig. 5-B. After reduction with forearm in splint. Fig. 5-C. Ten weeks later.

REDUCTION

Routine Technique comprises the following essential steps (Fig. 4):

1. Hypodermic, roentgenograms, local anaesthetic, and insertion of pins.
2. Installation of forearm in apparatus.
3. Application of upper segment of cast, incorporating superior pin, followed by mechanical reduction and x-ray check-up.
4. Completion of cast, incorporating distal half-pin.
5. Removal of casted arm from apparatus and covering of pin ends with plaster.

1. *Pin Insertion* (Fig. 4-A). The forearm is carefully prepared for a distance of several inches above the elbow and below the wrist. By rotary hand pressure alone, the thin pin is forced through the skin and the upper end of the ulna at a point about three fingers distal to the tip of the olecranon (Fig. 3-*b*). The half-pin is inserted through the center of the radius from its lateral aspect, about two fingers' breadth superior to the tip of the styloid process (Fig. 3-*a*). It is forced in until the inner flange is about a quarter of an inch from the skin, the intervening space filled with three-inch gauze dressings and similar dry dressings are spiked over the superior pin. A layer or two of non-sterile sheet wadding is wrapped from the axilla to the knuckles, although an unpadded cast may be used. The cuff is next slipped above the wrist from the ulnar side, bending it to fit snugly over the padding.

2. *Installation of Forearm in Splint* (Fig. 4-B). It is imperative that the forearm rest easily in the apparatus, accomplished by tilting the apparatus so that the distal horseshoe is raised well above the level of the elbow. The shoulder on the injured side should project over the edge of the table. The outer flange of the half-pin is placed against the horseshoe, and the stud pin is fastened so that the cuff holds securely against the forearm. The superior pin is fastened so that the elbow lies in the center.

3. *Application of Upper Segment of Cast Plus Mechanical Reduction* (Fig. 3-C). With the elbow at right angles, a section of the cast, incorporating the pin, is applied from the axilla to within a few inches below the upper pin, thus preventing the elbow from sliding on the pin. The fracture is now mechanically manipulated and the clinical reduction, including the position of the half-pin, is roentgenographically checked. If the half-pin projects through the radius and impinges on the ulna, correction is made by loosening the nut holding the stud pin: then the distal forearm is gently slid ulnarly away from the inner flange.

4. *Completion of the Cast* (Fig. 4-D). The snug-fitting cast, incorporating the pin and flanges, is extended to the knuckles.

5. *Removal of Casted Arm from Apparatus* (Fig. 4-E). When the plaster is set, the pins are released from the splint and their exposed ends corked and held by plaster bandage. The stud pin is unscrewed, the threaded hole left uncovered. The entire cast from end to end is split

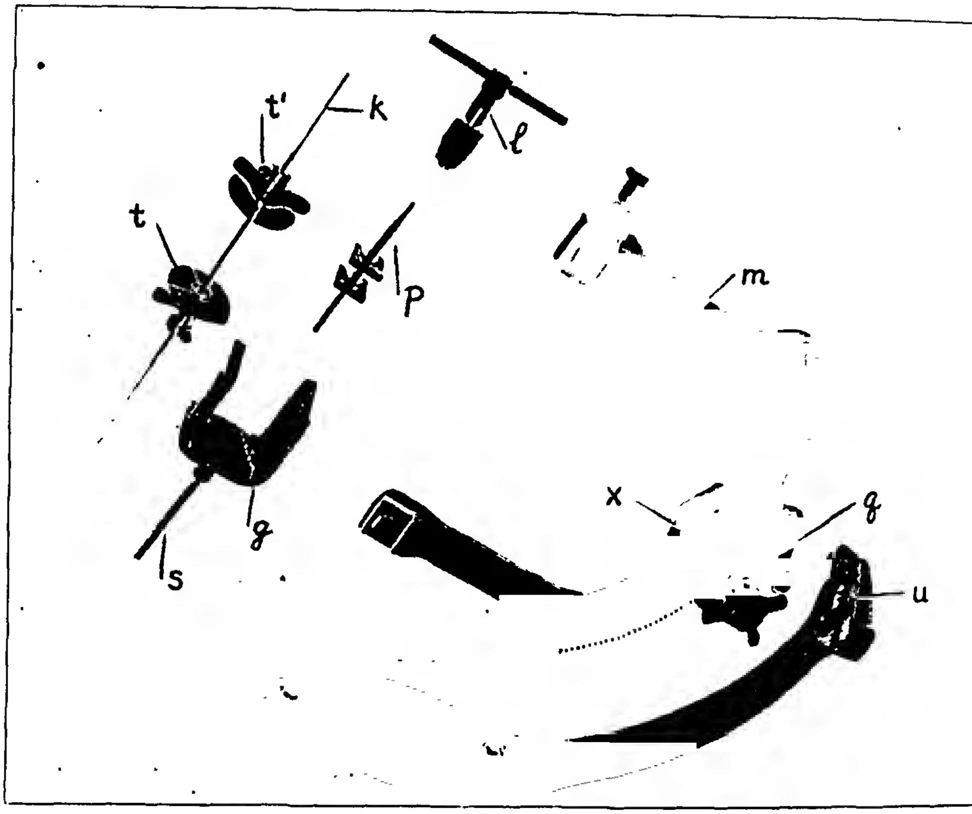

FIG. 6

Attachments.

g. Flexible aluminum rubber-lined cuff.
k. "Kiddie-Kar" spoke.
l. Pin handle. (This article can be purchased at the Ten-Cent stores.)
m. Stainless steel horseshoes for Kirschner wire, spoke or pin with attached wire tightener. Horseshoe can be fitted into either usual end bracket or the side bracket.
p. Half-pin with attached flanges.
q. Horseshoe base swiveled for sidewise movement and racked for rotary movement. It can also be fitted to side bracket or directly into frame of splint (Fig. 2-*z*).
s. Detachable stud pin.
t. Expanded "tautner".
t'. Contracted "tautner" showing full-length slot.
u. Side bracket, which permits reduction with elbow in full extension.

down to the sheet wadding, and spread open on the first symptom of circulatory interference.

AFTER-CARE

An outstanding feature of convalescence is the immediate ambulation.

One of the chief objectives of repeated roentgenograms is to check *direct end-to-end pressure contact.* Separation, due to overtraction or subsequent absorption—especially in transverse fractures—is a serious finding demanding immediate attention. Correction is made by fenestrating the cast just below each respective end of the ulnar transfixion, so that the pin can be displaced distally and reincorporated. Another procedure is the removal of a complete circular section of the cast, of sufficient thickness to ease the traction. It is better to obtain contact even at the cost of some shortening and misalignment, for separation,

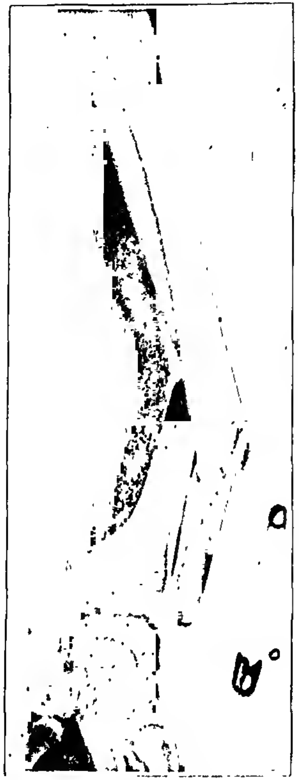

FIG. 7-A

FIG. 7-B

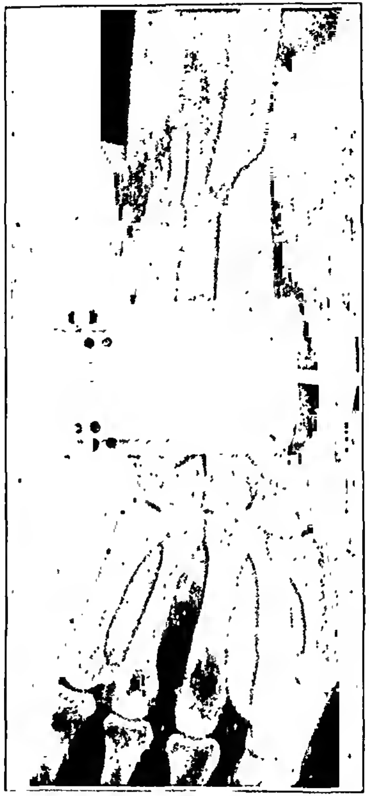

FIG. 7-C

FIG. 7-D

Mrs. E. K. Extensive compound comminuted fracture of the forearm.

Fig. 7-A. Lateral x-ray, before reduction. Fig. 7-B. Anteroposterior view, before reduction.
Fig. 7-C. Result of roentgenographic check, immediately after reduction, with forearm still in splint. Note separation of fragments due to overtraction, also overdepth of insertion of half-pin, two conditions easily corrected.
Fig. 7-D. Lateral view of forearm, after reduction.

especially in adults, is a common cause of that dreaded delayed union or non-union.

Should the cast become loose, a longitudinal section may be removed or a new cast applied. Angulation may be corrected by wedging or fenestrating the cast over the deformity and bandaging down a piece of soft felt.

Too much emphasis cannot be placed on the imperativeness of maintaining joint function. If full finger movement be insisted upon from the first, physiotherapy, which all too frequently delays or refractures the union, may be postponed until sufficient callus is present.

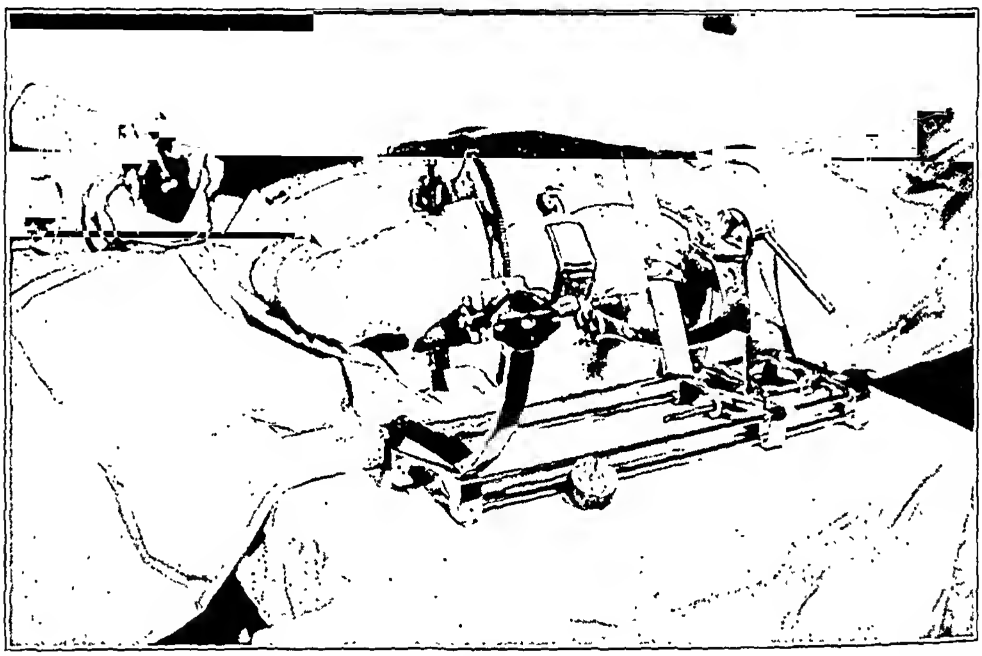

FIG. 8

Compound fracture reduced with wire through ulna, employing stainless steel horseshoe and side bracket. With the aid of "tautners" the wire was kept taut without the need of incorporating horseshoe in cast.

To remove the pins, time varying from the second to the sixth week, the cast is first freed from around the cuff, and, upon its removal, a circular hole is cut out around the half-pin, after which it is pulled out laterally with its enmeshed island of plaster. A four-inch hole is then made around the lateral end of the superior pin which is removed after cleansing. The usual slow rate of healing and the proneness to refracture call for splint protection over a long period of time.

OPTIONAL TECHNIQUES

A Kirschner wire, or better still a wire made from a "Kiddie-Kar" spoke, has been used successfully to replace the superior pin (Fig. 6). In order to tighten the wire a stainless steel horseshoe (m) is utilized, which is quickly fitted into the base (q) by removal of the nut (x). Moreover, expanding "tautners" (t and t') have been devised to keep the wire or

spoke taut, without the need of incorporating the horseshoe in the cast. These "tautners" are slotted so that they can be slipped onto the wire from the side, where they are fastened by set screws.

Superior transfixion may be dispensed with, provided that the arm is thin and that the surgeon is proficient with plaster. In this event the upper section of the cast is applied with the elbow at right angles and, when set, fastened to the center of the horseshoe by a plaster bandage. The remaining technique is then carried out as usual. If skin lesions or compound wounds interfere with the usual site of transfixion through the upper end of the ulna, the wire or pin may be put through the olecranon or the lower end of the humerus (Fig. 3-*c*, *d*).

When exigencies demand, the forearm may be reduced with the elbow in full extension by substituting a side bracket (Fig. 6-*u*) for the end bracket (Fig. 2-*c'*).

Compound Fractures: Fresh compound fractures that are not extensive are economically debrided and closed by primary suture. For the more extensive cases that cannot be closed Orr's vaselin-gauze method is preferable, while cases received late for treatment and old cases with complications may be equally well cared for by either Orr's method or Baer's maggot treatment. Furthermore, this new splint lends itself admirably to chemico-irrigation, as the forearm may be left fully exposed in the splint. If the wound is in the center, pins may be incorporated in their respective small plaster segments, leaving the central portion free for chemical lavage. Should complications develop, with a forearm already encased in plaster, the technique may even be reversed and the casted forearm replaced in the splint and the plaster partially or entirely removed without any interference with reduction. In brief, whichever type of treatment fulfills the need, treatment of the fracture is never a secondary issue to soft-tissue repair.

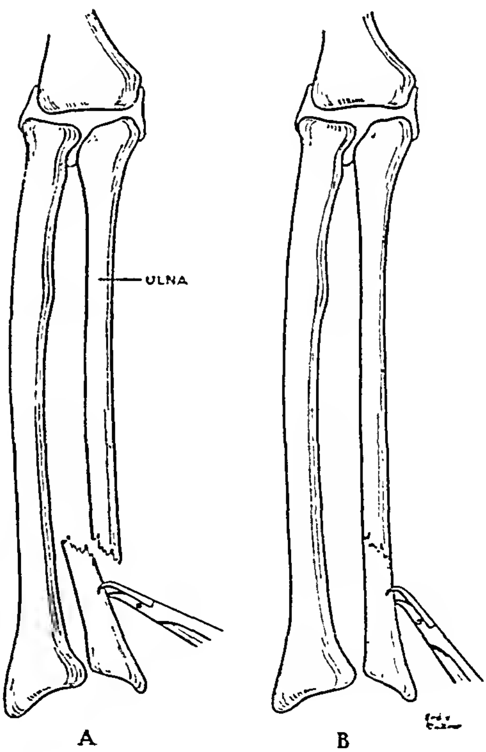

FIG. 9

Graphic representation of treating a fracture of the ulnar shaft with the use of a towel clamp. See text for details.

Traumatic Soft-Tissue Complications: Extensive in-

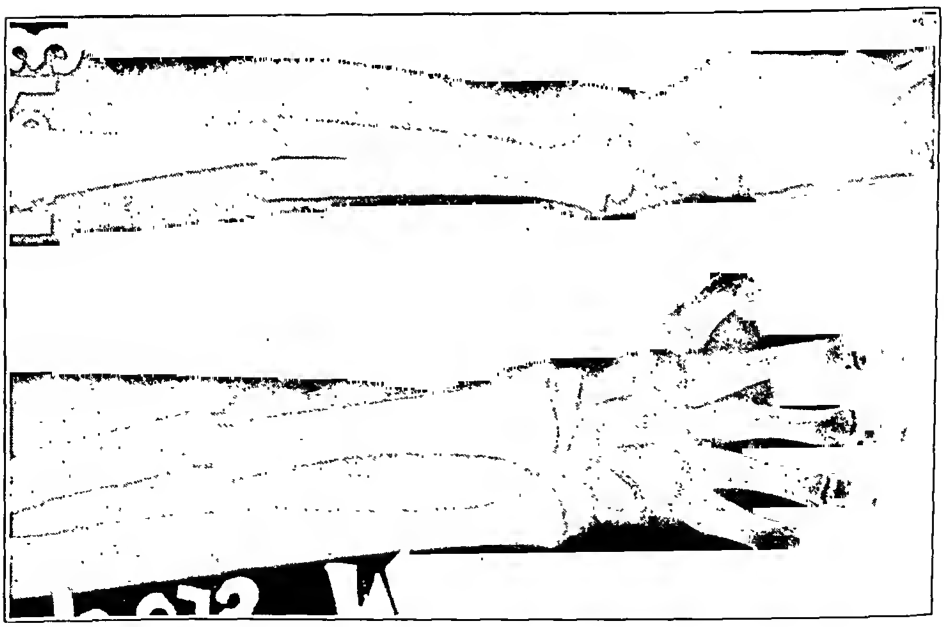

Fig. 10-A

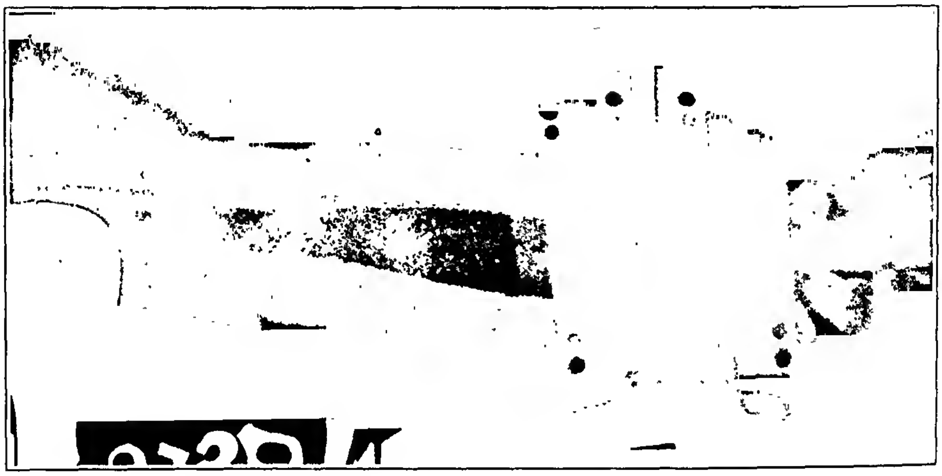

Fig. 10-B

Fig. 10-C

Master J. C., eight years old.

Fig. 10-A. Anteroposterior and lateral views prior to reduction.

Fig. 10-B. Anteroposterior view following reduction.

Fig. 10-C. Lateral view following reduction.

tegumentary injuries, with loss of skin or muscle, which naturally preclude plaster immobilization, can now be treated by leaving the forearm in the splint with the fragments immobilized. Furthermore, as the apparatus is not attached to the bed, the patient may be moved to the operating room without disturbing reduction. Again it is evident that healing of the osseous and integumentary tissues takes place simultaneously.

For non-union and malunion conditions the splint is autoclaved and the arm prepared from the axilla to the finger-tips. Plastic surgery may either precede or follow clamping of the forearm in the apparatus, as all the mechanical adjustments can be performed in an aseptic manner.

If an olecranon fracture complicates a fracture of both bones of the forearm, all may be simultaneously treated, the olecranon separation being reduced by a new flexion method[1]. The only additional technique is to insert a third pin or wire through the superior olecranon fragment. After the forearm has been placed in the splint, with elbow at right angles, traction applied to this third pin accomplishes olecranon reduction. Then the upper segment of the cast is routinely applied, incorporating both the upper pins, whereupon the forearm fracture is reducible in the regulation manner.

When a fracture of the humerus complicates a fracture of both bones of the forearm, the upper pin serves in a dual capacity: countertraction for the forearm fracture and the skeletal traction for reducing the fracture of the humerus.

Fractures of the radial shaft alone not infrequently resist the usual manipulatory means, especially those in the distal forearm, because the pronator quadratus pulls the lower fragment medially against the ulna. These readily respond to our routine technique.

A fracture of the shaft of the ulna, not complicated by a radial fracture, and unreducible by manipulation, can be controlled with the aid of a pin or towel clamp (Fig. 9). Since the dorsomedial edge of the ulna normally lies just subcutaneously, the displaced fragment can be grasped and brought into position

FIG. 11
Immediate ambulation illustrated.

with a large towel clamp or single-toothed uterine vulsellum. Ski preparation is the same as for a pin, and the clamp is incorporated i plaster where it remains until a supporting callus has been laid dowr The arm is generally casted with the hand in pronation and the elbo at right angles.

GENERAL CONSIDERATIONS

This new method for fractures of both bones of the forearm, while cor forming to anatomical principles and operating on physiological bases, ha many advantages, the chief of which are the ease of obtaining and th positiveness of holding the reduction.

Reposition is readily effected even under local anaesthesia, for th apparatus overcomes all muscular contraction so smoothly and painlessl that the patient's apprehension is soon allayed. Since this process i practically automatic, skilled assistance is obviated.

The high percentage of successful reduction of these difficult fracture is attributable to the specialized form of double skeletal transfixion whicl when operated with the automatic tablette, provides a quick, yet neve varying, means of mechanically obtaining extension, rotation, and ab duction or adduction. Therefore, this process is a prophylaxis agains open operations and should lift the veil of pessimism which clouds th literature on this subject.

Rotation manipulation is normally accomplished through the efficac of the half-pin, and so perfected is the construction of the machine tha the axes of rotation correspond regardless of angle or location of pi insertion or of difference in type of horseshoe. Furthermore, reductio can be carried out with the elbow in either flexion or extension, with th assurance of no variation in the axes of rotation.

Without deviating from the basic principles of this anatomical doubl transfixion mode, a variety of procedures are available, ranging from th usual all-plaster cast, padded or unpadded, to complete exposure of th forearm fixed in the tablette throughout convalescence. This latte form of fixation permits the removal of the patient to the operating roon or to the x-ray room, should the hospital be unequipped with a portabl machine. As plaster retention allows immediate ambulation followin a brief hospitalization, required only for reduction, many patients ca return immediately to work of a supervisory nature. This capacity t avoid confinement, the discomforts of adhesive traction, and the danger of open reduction, added to the economic saving, is a benefit of great value

As inferred, the technique is so elastic as to fit the individual case and multiple fractures of the arm may be treated with only a slight addi tion to routine measures. The regulation superior transfixion is simul taneously utilized in treating forearm fractures plus a complicating fractur of the olecranon or a fracture of the humeral shaft. Routine techniqu also replaces radial-shaft fragments, when the ulna remains unbroken Wide preference is permitted in technique for compound fractures, from

Orr's occluding cast to complete exposure of the forearm in the splint for chemico-irrigation.

The size of the tablette has decided value, because the whole splint may be sterilized in the autoclave, thereby providing an entirely new surgical approach for conditions of non-union or malunion.

From the roentgenographic point of view, the apparatus is most successful. No metal obstacles interfere with visualization during fluoroscopic or film examination. This verification of reduction preceding cast immobilization saves both time and later embarrassment.

Both after-care and hospitalization are reduced to the minimum. Of primary import is the fact that fixation is guaranteed by the incorporated transfixion. It naturally follows that hospitalization with frequent visits is unnecessary with a system which requires no daily time-consuming adjustments. The pins, when firmly incorporated, are a source of little, if any, pain. As the patient is comfortable, very little attention is indicated, except an occasional office call for roentgenograms.

The difficulties generally encountered in treating these fractures are met by substituting the precision of the machine for the variable human element.

SUMMARY

An anatomical method, a closed process for treating fractures of both bones of the forearm, has been detailed. By a specialized double skeletal transfixion, in conjunction with a miniature fracture table, mechanical reduction and positive fixation are automatically achieved, a decided step toward our goal in fracture therapy,—maximum function in minimum time.

1. ANDERSON, ROGER: Olecranon Fractures, Treated in Flexion Position. (In course of preparation.)

ULTIMATE ANATOMICAL MODIFICATIONS IN AMPUTATION STUMPS

BY C. G. BARBER, M.D., CLEVELAND, OHIO

Laboratory of Anatomy, Western Reserve University

INTRODUCTION

These notes upon the dissection of fourteen amputation stumps were made with the desire to identify precisely the changes undergone by the soft tissues in the stump and the relation of these changes to those produced in the bones. They bring to a conclusion the series of studies reported in References 1, 2, and 8. Our material is recorded in Table I; the protocols are recorded in the laboratory but omitted here for the sake of brevity.

TABLE I

Dissected Amputations (Human)

Site	Number	Specimen No.
Upper Arm	4	730, R; 1531, R; 1456, R, L.
Thigh	4	1519, L; 1332, L; 1686, R; 1991, R.
Leg	5	1800, R; 1471, L; 1995, L; 1697, R, L.
Foot	1	1471, R.
Total	14	

Dissected Amputations (Rats)

Site	Number	Specimen No.
Fore limb	4	495, R, L; 436, R, L.

CHANGES IN MUSCLE

The most striking single fact illustrated by the muscles of these fourteen stumps is their persistence as well nourished functional units, except where local trauma has resulted in their destruction or fibrous transformation. The atrophy of muscles in amputated limbs is strikingly different from that seen in cases of infantile paralysis, leprosy, and brawny oedema, which we have had the opportunity to dissect. In these disorders the muscular tissue is pale and bleeds very little on section. It is largely transformed into fibrous tissue with an increased amount of intermingled

fat, the result probably of primary changes in the vascular supply. In spastic palsy, on the other hand, the atrophy is even less in amount than in surgical amputations and, as in the latter, there is slight if any vascular change.

In amputations through the lower limb or through the elbow, atrophy is not a marked feature. In our amputations above the elbow there was considerable diversity in extent of atrophy, for which the cause is not evident. Some show little or no atrophy; in others the atrophy is accompanied by a glazed and reddened skin, associated during life with angioneurotic signs,—such as sensations of cold and even ulceration.

The neuralgic pain in amputations below the knee has been ascribed to vigorous growth of the fibular remnant, and this indeed may occur. Our dissections, however, show that the fibular head slips downward from its mooring on the tibia and thus projects the fibular shaft into the subcutaneous tissue of the stump. This does not occur if an osteophyte locks the free fibular end to the tibial fragment.

APPEARANCE OF THE BLOOD VESSELS

The commonly accepted statement that blood vessels, when ligated, become obliterated and converted into fibrous cords on healing from the point of ligation to their first large proximal branch, was not confirmed in our dissections. The main arteries and veins, as well as their larger branches, through which the operative trauma had extended, were found to be patent and apparently unreduced in caliber almost to their very end, when they rapidly dwindled in size and terminated in the general scar. Indeed, the larger veins in some stumps were found to be dilated and tortuous near their termination.

FALSE NEUROMATA

A statement by Leriche and Policard "that disturbances of bone regeneration are more marked after section of the median, ulnar, and internal popliteal than after section of the radial or external popliteal nerves (the former being carriers of sympathetic fibers, the latter not)"[5] further increased our interest in the dissection of available amputations. It would have been significant, for example, if we had found the distribution of neuromata more common on one of these nerve groups than on the other. We have no objective evidence from our dissected specimens of a predisposition to form neuromata in any single nerve trunk or nerve group sectioned at operation.

Serial sections of false neuromata from our human amputations, for the most part, confirmed the findings of Huber and Lewis[4]. Our sections and gross tumors, however, demonstrate that some neuromata are in part formed by a looping or coiling up of the nerve trunks. Neuromata on the sciatic nerve, to which the work of Huber and Lewis was confined, showed this tendency to a less degree, in our series, than did neuromata on some of the other nerves.

THE RELATION OF BONE ATROPHY TO FALSE NEUROMATA, OSTEOPHYTES, AND PROSTHESES

In our three amputations of the upper arm, No. 1531, No. 1456, and No. 730, there were neurofibromata on all the nerve trunks severed at operation. In No. 1456 and No. 730, clavicle and scapula alike were not only atrophic but small in dimensions, whereas the atrophy in No. 1531 was negligible (See Table II). It would seem, therefore, that changes manifest in the bones of upper-extremity amputations do not necessarily accompany the development of neuromata.

TABLE II

Measurement of Atrophy in Amputations Through Upper Arm

	Scapula				Clavicle			
	Weight		*Length*		*Weight*		*Length*	
No.	Sound	Amp.	Sound	Amp.	Sound	Amp.	Sound	Amp.
1531	90	106	177	178	34	32	154	153
730	63	31	163	148	23	11	147	119
1456*	54	40	153	153	20	13	151	141

* Both arms amputated. Measurements under Amp. are those of the side amputated at higher level.

Again we were unable to confirm a relationship between neuromata and bone changes in amputations of the lower extremity. In No. 1519, for example, where no neuromata were present, and in No. 1995, where three of moderate size occurred, the bone changes were slight. In No. 1800 and No. 1991 small neuromata coexisted with quite marked bone changes. In No. 1686 there was a large neuroma on the sciatic nerve, but none on the femoral or obturator nerves. This specimen showed a rather marked degree of atrophy evident, both in the roentgenograms of upper femur and innominate and in a weight loss, amounting in the innominate to ten per cent. of the sound bone (Table III).

TABLE III

Measurement of Atrophy in Amputations of Lower Limb

No.	Amputation of	Weight of Femur Sound	Weight of Femur Amp.	Weight of Os Innominatum Sound	Weight of Os Innominatum Amp.
1519	Left thigh			231	227
1995	Left leg	499	428	208	201
1800	Right leg	369	260	187.5	187
1991	Left thigh			185	157.5
1332	Left thigh			210	177
1686	Right thigh			245	221
1471	Left thigh, Right foot	470	357	231	203
1697	Both legs (Right higher)	468	459	235 (left)	228 (right)

Osteophytes or bone spurs are at times so large or so placed as to interfere with the wearing of an artificial limb and proper functioning of the stump, but our specimens give no conclusive evidence of their necessary association with bone atrophy. In No. 1991 and No. 1332 which had large osteophytes and in No. 1686 and No. 1471 where osteophytic production was slight, the atrophy, as shown by loss in bone weight, was quite marked. No. 1550 presented a marked contrast to the above specimens. This was an amputation through the left thigh of a white man, aged forty-nine years. A very large osteophyte curved proximally from the distal end of the severed femur just medial to the linea aspera. The bones themselves had not the usual atrophic appearance characteristic of amputation stumps and, though atrophy was evident in the roentgenogram, it was very slight. The innominate bone on the side of the amputation was indeed eighteen per cent. heavier than that on the sound side.

If disuse plays as important a part in the atrophy of a stump as is generally supposed, an expression of the effects of wearing prostheses in lower-extremity amputations might be anticipated. But there are no characteristic changes in the roentgenograms of our four leg amputations, which show definite evidence of artificial legs having been worn to within a short time of death, to lend support to a disuse theory. The difference in bone texture, as illustrated in roentgenograms, was just as apparent as in amputation stumps where no prostheses had been worn. Hence it seems probable that a prosthesis has no real influence upon the degree of disuse atrophy.

In No. 1697 where both legs had been amputated below the knee, the right some two and one-half centimeters higher than the left, there was a slight though definite increase in atrophy of the right innominate bone.

Differences in weight, although not as dependable as roentgenograms in determining slight degrees of atrophy because of the normal variability of bone weight on the two sides, confirm in general the findings in the roentgenograms. In No. 1697 the right femur weighed two per cent. less than the left; the innominate, three per cent. less. In No. 1800, an amputation just below the right knee in a white man, aged sixty-one years, the difference, though extreme in the femur, amounting to twenty-nine per cent. of the sound side, reached but three-tenths per cent. in the innominate bone. In No. 1995, an amputation through the upper third of the left leg below the knee in a white man, aged sixty-seven years, the left femur, though practically one centimeter longer than the right, weighed fifteen per cent. less. In the innominate bone the loss in weight was three and three-tenths per cent. of the sound side.

Our dissections and roentgenograms give us no reason to believe that there is any relationship whatsoever between false neuromata of osteophytes and atrophy or modification in dimensions of the bones in amputation stumps.

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EPIPHYSEAL UNION IN AMPUTATION STUMPS

It is exceedingly difficult to obtain evidence on epiphyseal union of bones in stumps but, having followed one of our clinical cases for eight years, we have, we believe, suggestive information upon the course of events in young people.

E. Sc. is a white boy who, at the age of twelve years, following an automobile accident, suffered amputation through the lower third of the left humerus. Owing to the formation of a conical stump, the humerus was reamputated at about its middle three years later. A roentgenogram taken three years and six months after the original amputation shows a good, rounded, soft stump with a capped medullary cavity, marked gracility of humeral-shaft remainder, slightly less well marked differentiation of features of upper humeral extremity, gracility of clavicle, but no obvious change in scapula. Subsequent roentgenograms, taken five years and five months after the original amputation, show the upper humeral epiphysis and also the epiphysis forming the outer end of the acromion completely united on the amputated side alone. These unions should not occur until between the nineteenth and twentieth birthdays[7]. Curiously enough the epiphysis which forms the coracoid angle is but partially united as on the sound side. A small center of ossification has appeared at the outer end of the left clavicle on the amputated side. This should not be present until between the nineteenth and twentieth birthdays[6]. The ununited epiphyses and the unossified epiphysis at the outer end of the clavicle in the right shoulder are entirely in accordance with the patient's age and clearly demonstrate the precocious epiphyseal maturity on the amputated side. The difference in date of epiphyseal union on the two sides is not accidental, for in our study of several hundred adolescents in this laboratory we have never seen it. As an evidence of early cessation of growth of the amputated limb it may, in part, explain the difference in dimensions of scapula and clavicle after amputation above the elbow. Even if we admit this contention, the retarded growth or premature arrest of growth on the side of amputation cannot wholly explain the extreme difference in dimensions and weight of our No. 730 and No. 1456. No explanation, other than actual postamputation atrophy, will suffice to explain the tremendous difference in size between the right and left scapulae and clavicles of these specimens. We are, however, still completely at a loss to account for the finding that pronounced atrophy occurs only after amputation above the elbow of the upper extremity and not at all in the lower limb.

DISSECTION OF EXPERIMENTAL AMPUTATIONS

Through the courtesy of Dr. Harold Colson of Flagstaff, Arizona, and Dr. H. H. Donaldson of the Wistar Institute, we have obtained the bodies of nine rats in which Dr. Colson had amputated the humeri through the middle of the shaft between the fifth and the twelfth days after birth.

These rats were sacrificed at different dates from 30 to 265 days after birth. In none of these rats was the epiphysis for the upper end of the humerus united. One would hardly expect union of this epiphysis before 265 days, especially since rats of the Wistar Colony tend to show delayed union[3]. There was also no union in the epiphyses of the vertebral border or lower angle of the scapulae. All the rats were, therefore, killed before they attained skeletal maturity.

The humeral remnant shows varying degrees of gracility and, in some examples, a small osteophyte arising from the amputated stump. There is no indication of marked osteoporosis in humerus or scapula on roentgenographic examination and neither scapulae nor clavicles show the slightest sign of reduction in dimensions or of failure to develop adequately.

We have dissected the amputation stumps on rats 436 and 495 with the following results:

Rat 436—Right: flat false neuroma on ulnar nerve only.
Left: moderate-sized neuroma on ulnar nerve, small neuroma on median nerve. No other neuromata.

Rat 495—Right: no neuromata.
Left: moderate-sized neuroma on ulnar nerve only.

All humeral remainders in the nine rats show gracility of shaft.

The presence of neuromata upon nerves in the rats dissected indicates that there would be neuromata in the other animals, the bodies of which were macerated before we received them. The positive evidence obtained from rats 436 and 495 supports our belief that neuromata are not related to the degree of bone atrophy. However, it is not at all certain that the postoperative findings on amputations in forelimbs of rats can be transferred to a study of amputations in man. In the absence of real atrophy and in tendency to form osteophytes, the rat amputations resemble amputations of the lower extremity in man, not of the arm above the elbow. It is quite conceivable that emancipation of the forelimb in man and other primates from a weight-bearing function involves a profound difference between primate and quadrupedal function of the anterior limb. It does not appear that the rat or any other quadrupedal mammal is a suitable animal for experimental purposes in the effort to analyze the causation of postoperative phenomena in human amputations.

GENERAL CONCLUSIONS

1. Postoperative atrophy is seen in muscles as well as in bones. It is subject to considerable variation and is accompanied by angioneurotic symptoms of varying degree.

2. Atrophy in amputations of the lower extremity (and forearm) (See References 1 and 2) is limited in extent and in time. In amputations above the elbow it may be very pronounced indeed, and accompanied by trophic changes in the skin.

3. The atrophy of amputation is more marked than that in spastic palsy, but differs radically from that found in infantile paralysis, leprosy,

and brawny oedema because, except in the area of local trauma, the muscle of amputated stumps is never transformed into fibrous tissue.

4. The larger blood vessels retain practically their normal caliber to within a short distance of their termination, when they dwindle rapidly in size and end in the general scar.

5. A special tendency to the development of neuromata on all the nerve trunks severed at operation in amputations above the elbow is evident in our dissections. The tendency is less evident in posterior tibial and sciatic nerves and rarely present in femoral and obturator nerves of lower-extremity amputations.

6. There is no evidence in these dissections to warrant the assumption that false-neuroma formation is in any way related to the degree of bone atrophy.

7. The characteristic atrophy evidenced by loss of weight and osteoporosis identifiable on roentgenograms is present whether or not a prosthesis is worn.

8. Osteophytic production, less marked in amputations of the upper extremity than in those of the lower, has no direct relationship to the degree of bone atrophy.

9. Amputation, at least in the upper arm, may hasten the date of epiphyseal union and thus apparently arrest bone growth.

10. Experimental amputation of the upper arm in rats results in phenomena resembling the postoperative changes in amputations of the lower limb in man and not those in amputations of the upper arm.

11. The rat, being a quadrupedal mammal, is not a suitable animal for a study of postamputation changes as found in man.

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ADAMANTINOMA OF THE TIBIA *

BY EDGAR HOLDEN, JR., M.D., AND JOHN W. GRAY, M.D.,
NEWARK, NEW JERSEY

From the Surgical and Pathological Departments of the Hospital and Home for Crippled Children, Newark

Adamantinoma or adamantine epithelioma has long been known as an entity, and ordinarily occurs in the jaw. It might be inferred from earlier reports on the subject that it is a rare tumor. Murphy [1], in 1924, estimated that about one hundred cases had been reported in the literature. Kegel [2], however, in reporting thirty-five cases from the Johns Hopkins Hospital in 1932, concluded that many cases were unrecognized.

The rate of growth of the adamantinoma is slow. Seven of Kegel's [2] cases showed a duration of the primary tumor of fifteen years or more. Occasionally there is a rapid growth of a tumor that has remained stationary for years. The behavior of these tumors is similar to that of a basal-cell carcinoma,—that is, they do not metastasize but persistently recur unless completely destroyed. Patients may experience several years without symptoms between recurrences, the average interval between primary and secondary operations being five years.

Adamantinoma is an epithelial tumor, fundamentally basal-cell in type, in which all degrees of differentiation of the enamel organ are found. In the less differentiated form, basal cells only are seen. In the more differentiated forms, most frequently seen, there are branching epithelial strands and groups composed of a peripheral cylindrical layer of cells and a central network of stellate-shaped and transitional cuboidal cells.

Central-jaw tumors frequently cannot be diagnosed from the history or from findings at the examination. The differential diagnosis of root cyst and follicular and dentigerous cyst can usually be made under the microscope. Giant-cell tumors, central fibromata, fibrosarcomata, and chondromata can be distinguished by the microscopic pictures, if not preoperatively or by gross pathology. Carcinoma of low-grade malignancy, arising from the mucous membrane and secondarily infiltrating the jaw, can be recognized microscopically.

There are three main points of view regarding the origin of adamantinomata: the tumor develops from (1) the paradental débris, (2) the oral epithelium, and (3) the enamel organ. Malassez [3] pointed out that in the development of the tooth, the epithelial, enamel-producing portion of the tooth germ extends downward into the gum to the very apex of the future tooth. On completion of the enamel cap, this epithelium persists in an irregular cell strand, extending down along the side

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of the tooth to the apical foramen. To this paradental débris Malassez[3] attributed the origin of root cysts, follicular or dentigerous cysts, and adamantinomata. Perthes' observation[4] that root cysts, which undoubtedly arise from these remnants, never contain enamel or dentin, while follicular cysts and adamantinomata do, is proof that Malassez' epithelial rests have lost the power to form teeth or tooth remnants.

The oral epithelium has been suggested as a point of origin because of the discovery of a direct connection between the oral epithelium and the adamantine epithelium. But Kegel[2] shows that adamantine epithelium not infrequently comes in contact with the oral epithelium and sometimes invades it, that the morphological similarity common to all basal-cell carcinomata is no proof of genetic relationship, and that the age incidence of carcinoma of the gum is several decades later than that of adamantinoma.

The third view, that adamantinomata arise by neoplastic transformation of the tooth germ, while the follicular cysts and the dentigerous cysts result from cystic degeneration of the same, was advanced by Neumann[5] and Magitot[6]. There is strong evidence in support of their theory. Adamantinomata in the lower jaw are situated in the region of the molars. In the upper jaw, the molars and lateral incisors are affected. They show a marked predilection to arise during that period in which eruption of the molar teeth takes place. The age group between sixteen and twenty shows the largest number of cases. In some instances, however, it would seem that the dental germ underwent neoplastic transformation at a much later date. The cause of neoplastic transformation has been ascribed to trauma, infection, and mechanical irritation.

Fig. 1

Roentgenogram, April 1931. Antero-posterior view of the left lower tibia, showing a multilocular cyst-like lesion.

Cystic formation is almost a constant microscopic observation of adamantinomata. This takes place in the central network of the epithelial groups. The stellate cells represent the enamel pulp of the four months' foetus and the peripheral cylindrical cells represent the ameloblasts or enamel-forming cells. As the tooth grows, the pulp cells furnish nutrition

to the ameloblasts. When the enamel has been formed, the pulp cells degenerate and disappear.

Extramaxillary adamantinomata are uncommon. Those occurring at the base of the skull are well recognized and their origin is traced to remnants of buccal epithelium in the neighborhood of the pituitary gland. For a complete review of this subject the reader is referred to the report of Critchley and Ironside[7] in 1926.

So far as we know, the only other extramaxillary adamantinomata are the exceedingly rare adamantinomata of the tibia. In studying the literature we found only three authentic cases recorded. The first case was reported by Fischer[8] in 1913, the second by Baker and Hawksley[9] in 1931, and the third by Ryrie[10] in 1932. A case of adamantinoma-like tumor of the tibia was also reported by Richter[11] in 1930.

Fischer's case was that of a man, aged thirty-seven, who knocked his leg on a stair, suffering a slight, painful injury. Five months later a tumor developed at the site of the injury, and nine months after the trauma the tumor was resected. It was an epithelial tumor, morphologically characteristic of adamantinoma. He assumed that it originated from a foetal cell rest formed at the site during the intra-uterine period. This assumption was based upon the consideration that the potentiality of tooth formation is limited to that period in foetal life during which the tooth germs are formed. He concluded that later cell rests would not have this potentiality and that, if the tumor arose as the result of adult implantation, the structure would be pavement epithelium.

The second case, reported by Baker and Hawksley, was that of

Fig. 2

Roentgenogram, April 1931. Lateral view of cyst-like lesion in left lower tibia, prior to the first operation.

an engine driver, aged forty-six. He struck his shin with an iron bar, causing a mild injury with no skin wound, and seven months later a slight injury to the same region was associated with much pain, and a lesion of the bone was observed. Ten months after the first injury, the tumor was resected. Histologically, this tumor apparently showed a predominance of basal-cell growth. Baker and Hawksley followed Fischer in postulating a foetal epithelial rest, but laid some stress on trauma as stimulating the rest into growth.

The clinical history of the third case, reported by Ryrie, differed from the others only in the long, latent period. In 1915 the patient, then aged thirty-six, was kicked on the shin. Only a superficial bruise resulted, although pain and tenderness were never entirely absent for a period of eight years. Then a swelling developed rather rapidly. An amputation was advised. The patient refused amputation, and nothing was done until 1931, sixteen years after the injury. The tumor was scraped out, and a histological diagnosis of adamantinoma was made. Six months later the tumor recurred, grew rapidly, and an amputation was done. The recurrent tumor showed less adamantinoma-like differentiation; in large areas the cells were spindle-shaped and there were very numerous mitotic cells. The tumor, however, was confined to the bone, and the soft parts were not invaded.

Ryrie emphasizes the etiological importance of trauma, a factor so prominent in all of the cases. He believes that the tumor originates from epithelium implanted at the time of injury, and, because of "thwarted repair", this epithelium ultimately passes over into tumor growth. He explains that the conditions in the superficial portion of the tibia are such as to favor laceration of the periosteum and hematoma formation, with subsequent ossification. Injuries which leave the skin unbroken may involve tearing, not only of connective tissues, but also of the deep skin appendages, such as the hair follicles. It is in the subsequent fate of these special epithelial tissues, Ryrie believes, that we must look for an explanation of our tumors. In the superficial soft tissues such damaged hair follicles are either absorbed or repaired, but, in the deeper parts in the region of the lacerated periosteum and of the organizing hematoma, conditions exist which constantly thwart complete repair. The tumor, when established, remains limited to bone, because adamantinoma is embryologically a basal-cell growth, and all tumors of the basal-cell type have a limited kind of malignancy with little ability to invade new types of tissue.

CASE REPORT

The patient, an unmarried female school teacher, thirty-six years of age, was first seen by the authors in April 1931.

She complained of pain and swelling of the left lower tibia. For several years pain had been noticed in the left lower leg when the patient was fatigued. Two years before the left ankle had been struck against a curb, causing an abrasion, contusion, and slight bleeding, and pain had increased since that time. During the six weeks before admission there had been pressure and a burning sensation, associated with pain, which was

increased by weight-bearing. The ankle had been strapped and was somewhat relieved by this support. There was no history of tumor growth in any other part of the body.

On examination it was found that there was a swelling of the left lower tibia on the antero-internal surface, about ten by six centimeters in size. The temperature was normal. There was localized tenderness, but no restriction of motion of the ankle or pain on motion. There was no enlargement of the inguinal or other superficial lymph nodes. The oral cavity, chest, thyroid, breasts, abdomen, pelvic organs, and bones were found negative for areas of tenderness or tumor formation. There was no pain, tenderness, or limitation of motion in any of the joints. No evidence of focal infection could be found in the teeth, sinuses, tonsils, gall-bladder, appendix, or cervix. The urinalysis and blood count were normal and the Wassermann was negative.

Fig. 3

Photomicrograph. Adenomatous type of lesion in specimen examined April 1931. × 200.

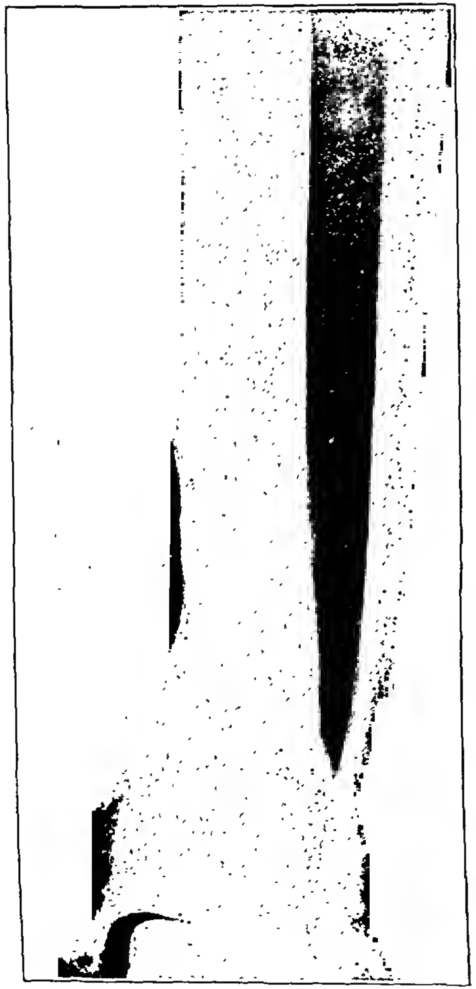

Fig. 4

Anteroposterior view of left lower tibia, June 1932, fourteen months after operation. Growth of dense normal bone is shown to be filling in the cavity. There is no evidence of recurrent tumor.

Fig. 5

Lateral view of left lower tibia, June 1932, fourteen months after operation. Increase of normal callus almost completely filling the cavity. No evidence of recurrent tumor.

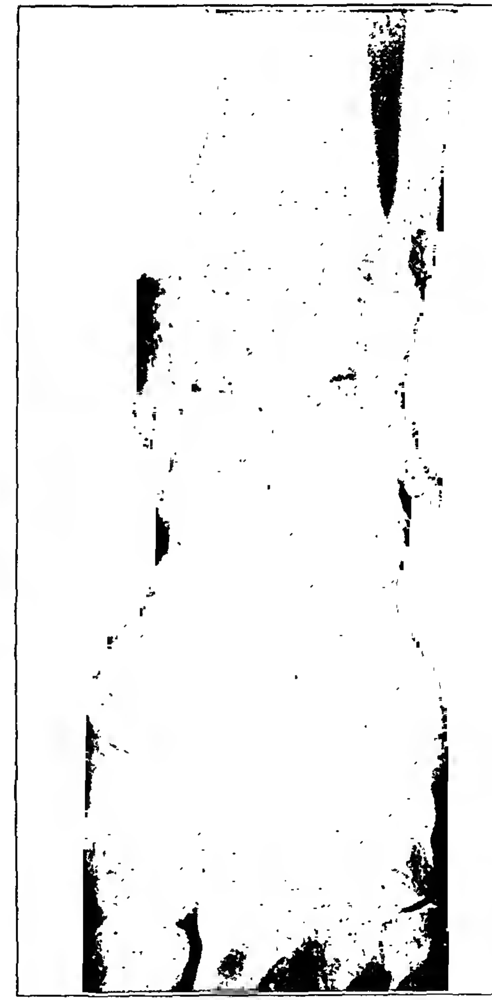

Fig. 6

Anteroposterior view of multilocular recurrent tumor, June 1933, twenty-six months after operation for the primary tumor. Above the tumor is dense normal bone which has filled the old cavity.

The results of an x-ray examination of the left lower tibia made by Dr. Charles F. Baker, April 13, 1931, were described as follows: "The examination shows the presence of a destructive lesion characterized by an area of decreased density, five by three centimeters in size, in the lower end of the tibia, three centimeters above the distal end. It has the appearance of a multilocular cyst-like condition with slight expansion of the bone toward the medial side. There is no bone reaction adjacent to the lesion. The margins are sharply delineated but not thickened. There is no evidence of invasion of soft tissue or break in the outline of the bone. It would appear, therefore, to be an inflammatory bone lesion of long standing. The multilocular appearance is suggestive of a giant-cell tumor but the epiphysis is not involved." (Figs. 1 and 2.)

After these examinations the patient was sent to the hospital, April 18, 1931, with a provisional diagnosis of bone cyst. An operation was performed and the entire mass was removed by gouge and chisel, keeping in healthy bone on all sides of the lesion.

Pathological Examination: Macroscopically, it was a soft loculated mass of grayish color. Microscopically, the growth was composed of adenomatous tissue surrounded by a great deal of fibrous tissue. The irregular gland structures resembled somewhat those of the endometrium. Columnar-type epithelial cells lined the acini and many were hyperchromatic and mitotic. In the fibroblastic stroma there were a few groups of cells resembling foreign giant cells. A diagnosis of adenoma malignum was made (Fig. 3).

This pathological diagnosis was disconcerting. One would not expect to find a metastatic growth in the lower end of the tibia, and there was nothing in the histological structure from which the primary origin of such a neoplasm could be determined. Nevertheless, three pathologists agreed upon the above diagnosis, and a further exhaustive search for primary malignancy was made and found negative.

Recovery was uneventful, the wound healed, and after three weeks the patient was discharged from the hospital without local pain or tenderness. Irradiation was considered but not used.

July 22, 1931. There was stiffness through the instep.

November 21, 1931. X-ray examination: "All diseased bone apparently removed and no evidence of recurrence. The cavity is being filled in by normal callus."

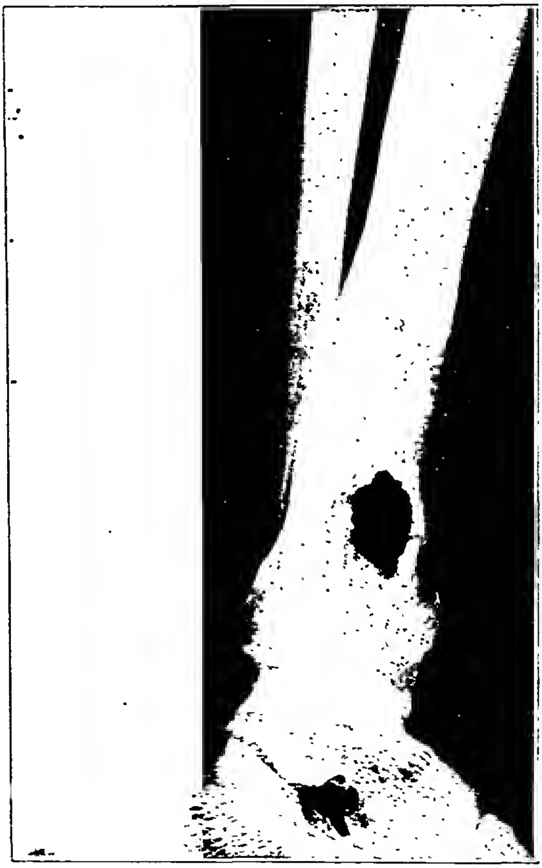

Fig. 7

Lateral view of the cyst-like recurrent tumor, June 1933. Except for a tiny area in the uppermost part, the old cavity is completely filled in by dense bone.

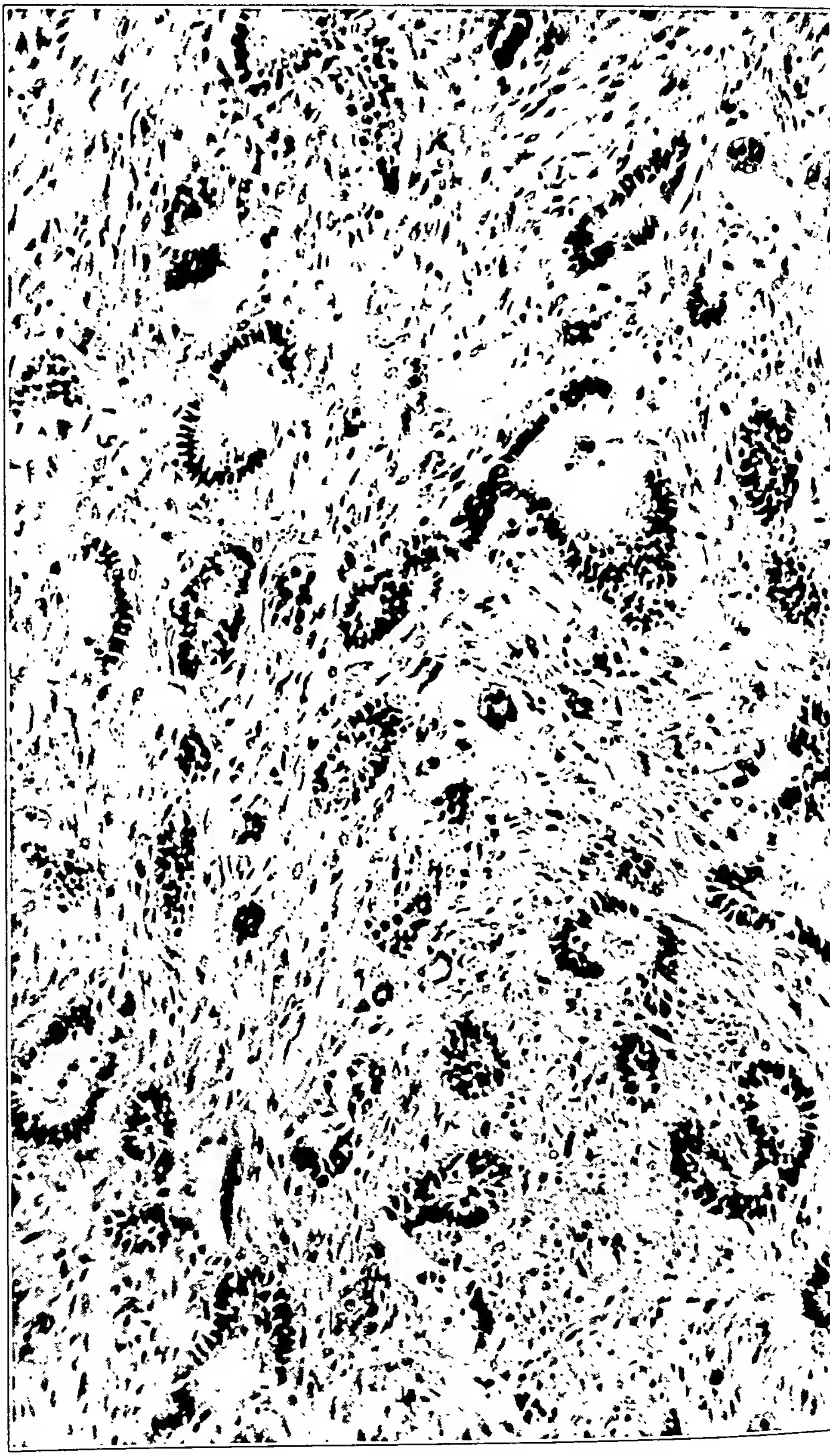

Fig. 8

Photomicrograph. An area in a section from the recurrent tumor simulating adenocarcinoma. × 280.

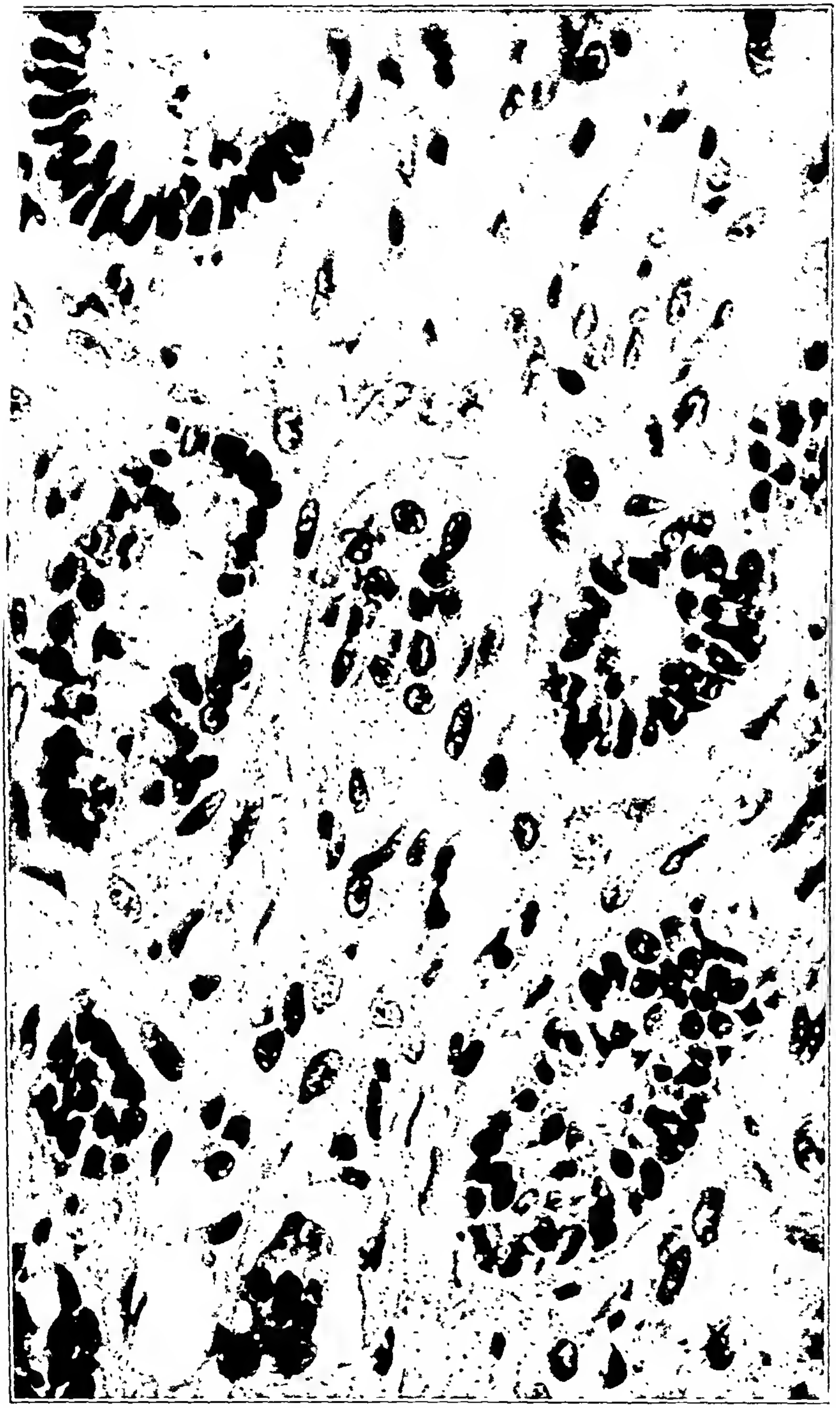

Fig. 9

Photomicrograph. Higher magnification of Fig. S, showing pseudoglands and a large multinucleated giant cell in the stroma. × 705.

December 4, 1931. Occasional shooting pain through the operative area with slight tenderness but no redness or swelling.

December 29, 1931. The left ankle was struck on the step of a staircase, causing slight temporary tenderness.

January 8, 1932. No tenderness, no pain. X-rays showed a very slight shadow which the roentgenologist considered of no significance.

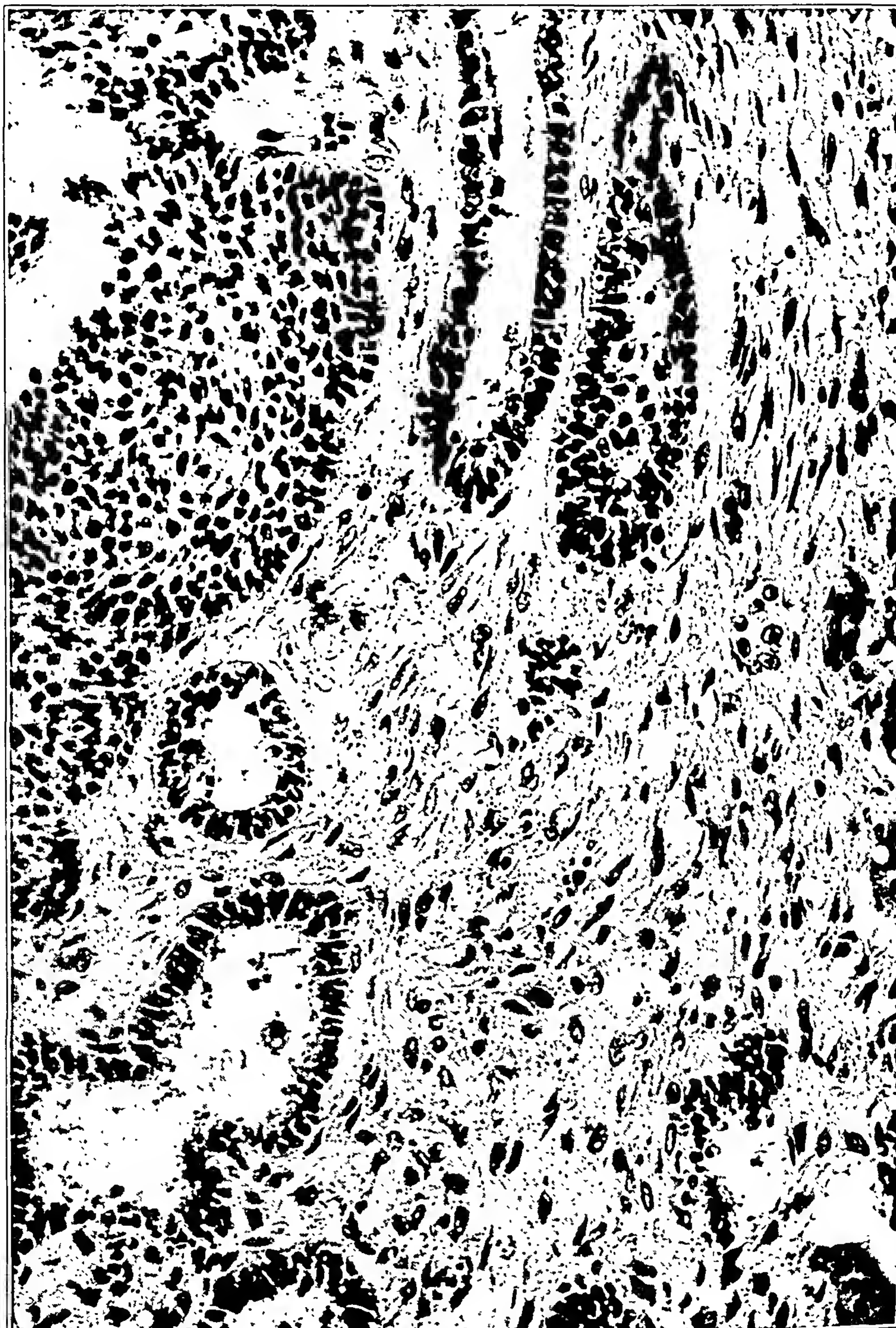

Fig. 10

Photomicrograph of recurrent tumor, showing adenomatoid structures and also a large epithelial group resembling somewhat basal-cell carcinoma. × 250.

June 25, 1932. No symptoms. X-ray examination: "There is an increase of normal callus almost completely filling the cavity. There is no evidence of recurrent tumor." (Figs. 4 and 5.)

June 29, 1933. The patient had been well during the past year. She had played

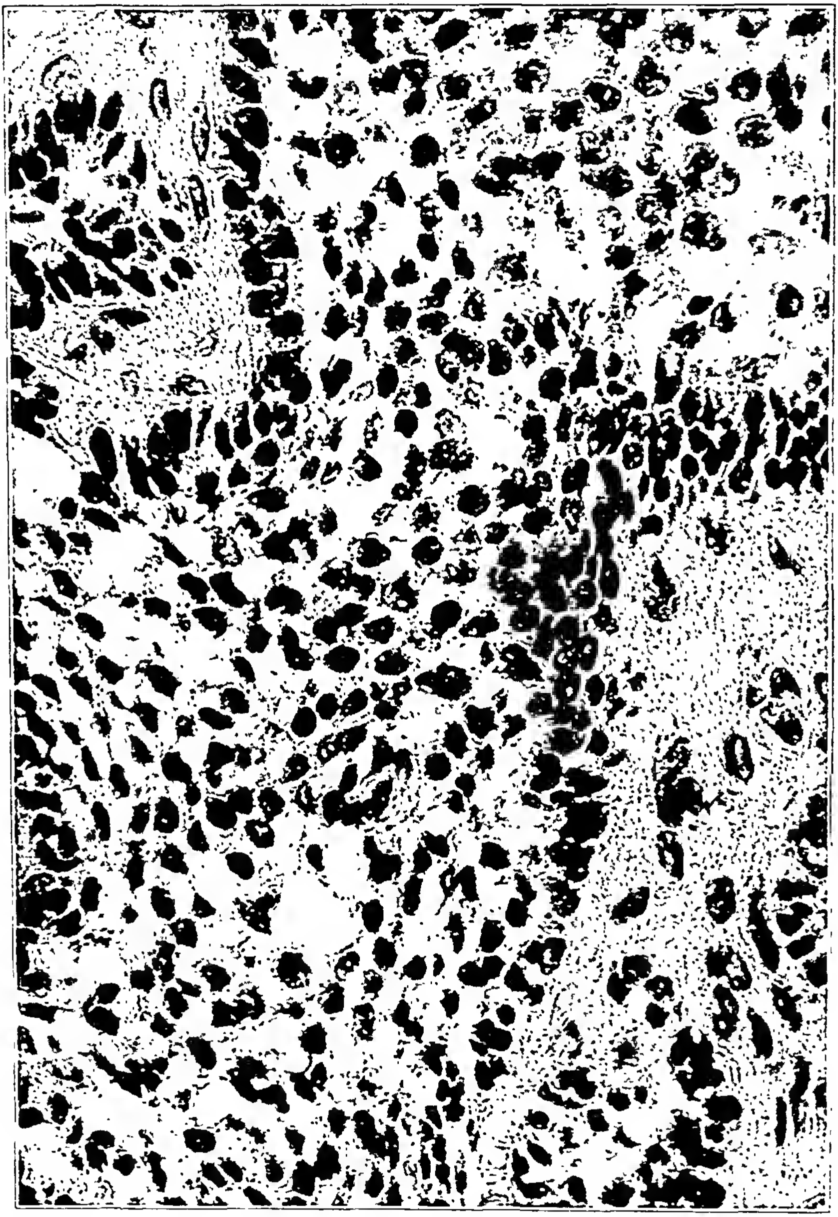

Fig. 11

Photomicrograph. A higher magnification of an epithelial group as shown in Fig. 10. It consists of a central network of spindle, cuboidal, and stellate cells and a peripheral layer of cuboidal or columnar cells. A small cyst is present in the central area. × 600.

tennis and entered into other active physical exercises. One week previously the ankle was "turned", followed by pain and swelling.

Examination: There was swelling around the external malleolus and in front of lower end of tibia, below the old scar. These areas of swelling were tender and there was also tenderness along the lateral ligaments. There was no pain in dorsal flexion, but some when the foot was put in varus and equinus.

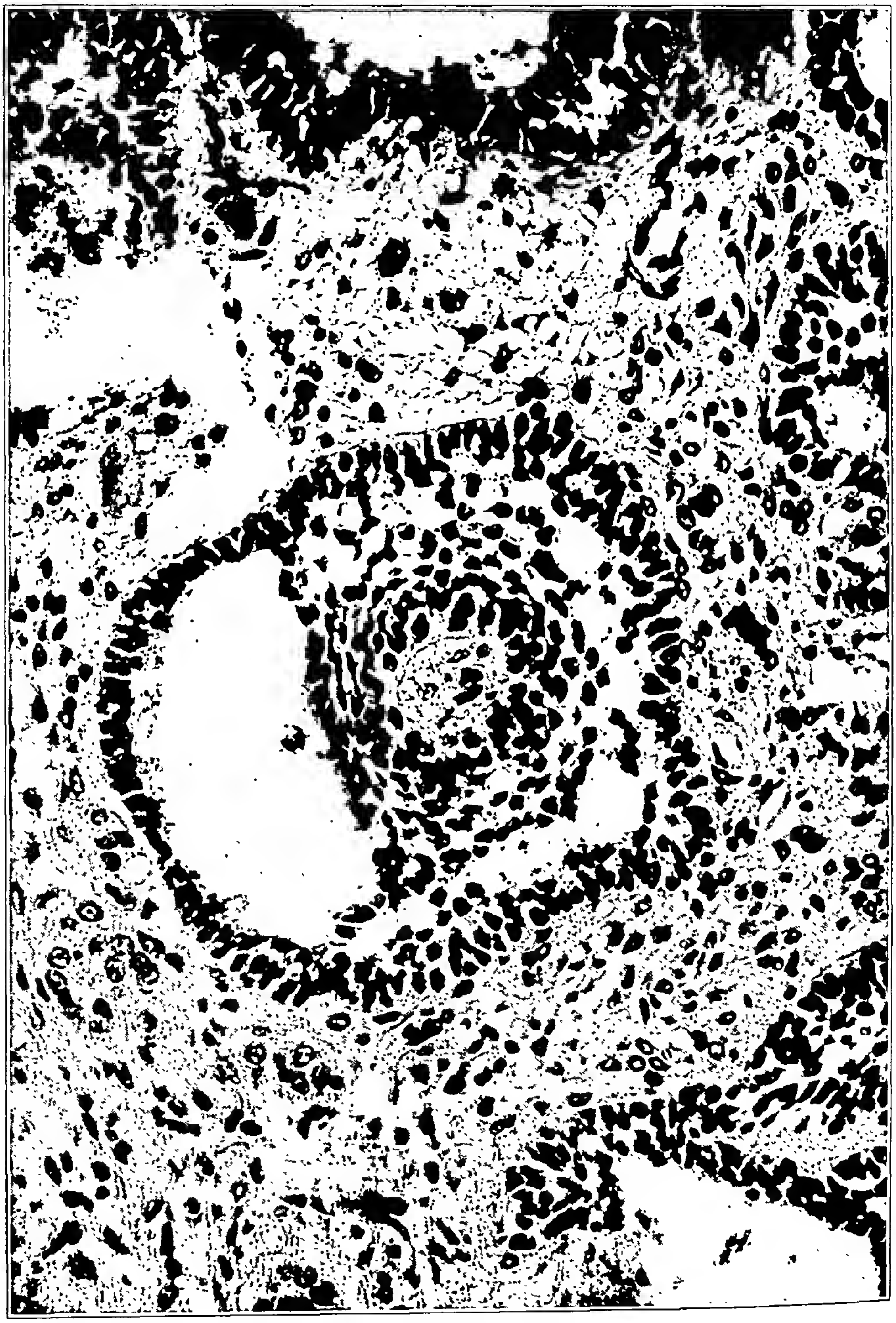

Fig. 12

Photomicrograph showing an epithelial group containing a large cyst, and also central necrosis of a group of cells in the network. The transitional forms and cystic character of pseudoglands are well shown in this section. × 500.

X-ray Examination: "Except for a very small area in the uppermost part, the old cavity is completely filled in by dense bone. At the lower end of this area there is a cyst, approximately two by three centimeters in size. The lower border of the cyst is only about one centimeter from the distal end of the tibia. In the anteroposterior view there is the appearance of many small cysts, but in the lateral view it appears as a single, large cyst, slightly irregular in outline, reaching the anterior surface of the bone. As in the

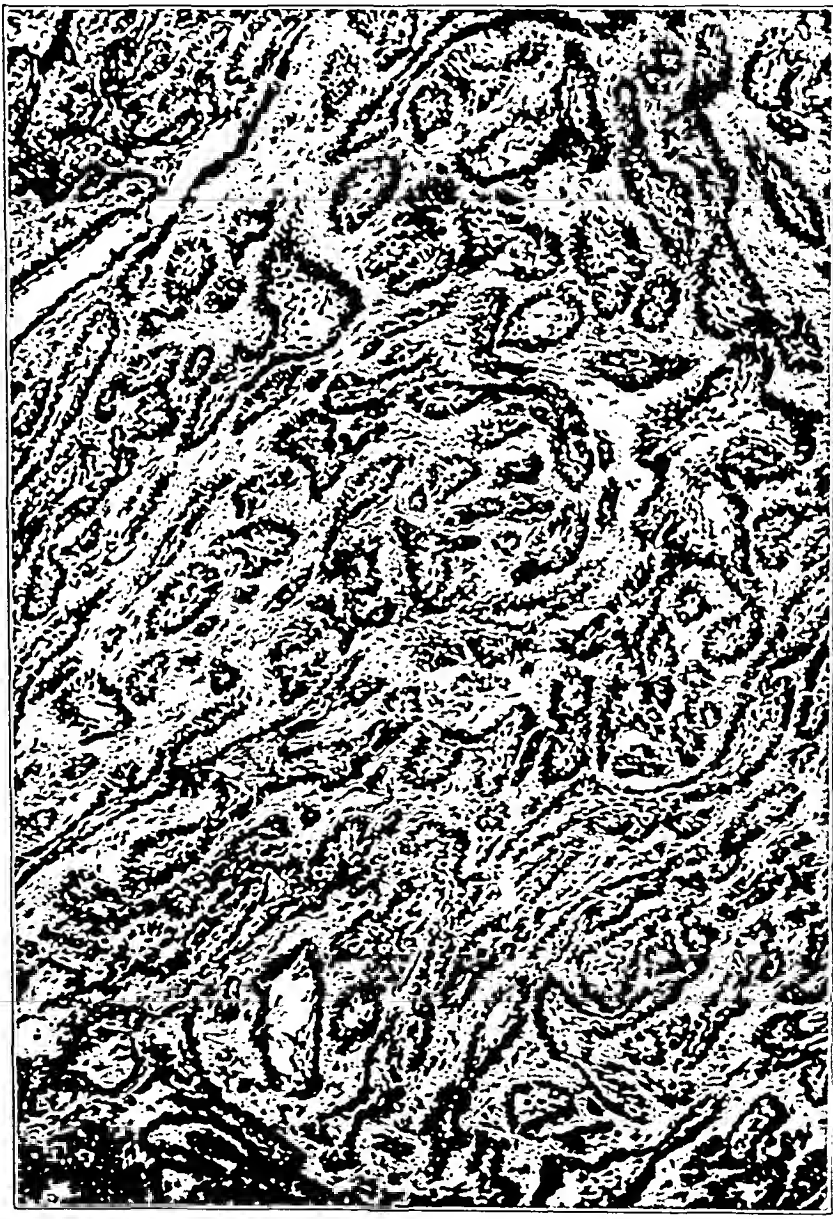

Fig. 13

Photomicrograph showing bizarre forms of epithelial structures in the recurrent tumor, characteristic of adamantinoma. × 80.

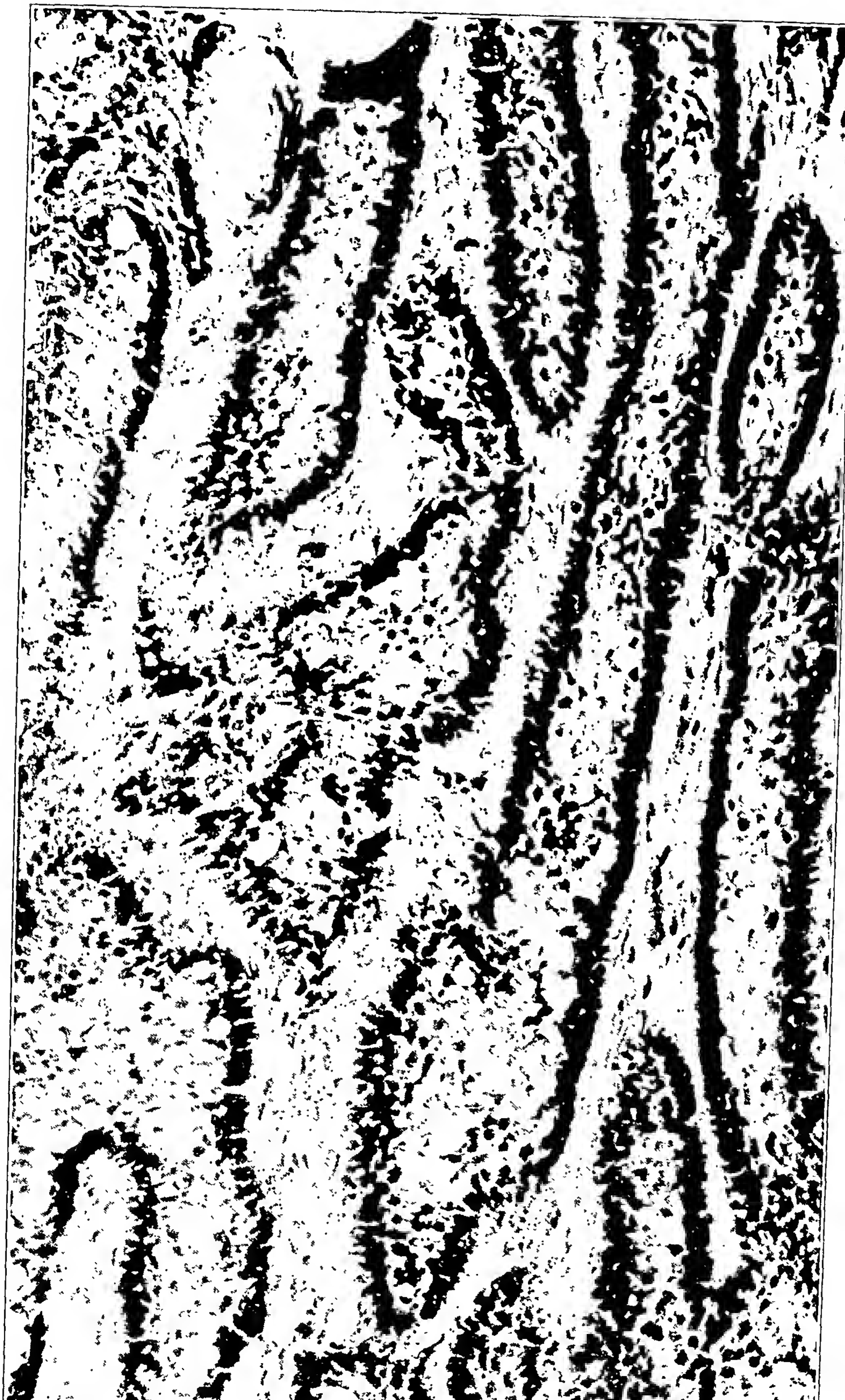

Fig. 14

Photomicrograph. Higher magnification of Fig. 13. In these finger-like projections of adamantinomatous epithelium the cylindrical peripheral cells (embryonal enamel cells) and the central stellate cells (embryonal enamel-pulp cells) are well shown. × 280.

Fig. 15

Photomicrograph. High-power magnification of a section from the recurrent tumor, showing cellular pleomorphism and a distinct mitotic figure. × 1000.

roentgenogram of April 1931, there is no bone reaction surrounding the lesion, nor is there any invasion of the soft tissue." (Figs. 6 and 7.)

X-ray examination of the long bones, chest, and maxillae, made July 1933, showed no pathological lesions.

July 17, 1933. Operation. On account of the old scar it was impossible to separate the skin and periosteum. It was found, in raising the periosteum, that there was an area about one and five-tenths centimeters in diameter where practically no shell of bone covered the mass. With a gouge the whole mass was removed well into healthy bone, except at the lower end where it extended near the joint surface. The cavity was curetted and chemically treated and the wound was closed with sutures. No inflammatory reaction occurred following the operation.

August 15, 1933. Wound healed. Patient discharged from the hospital walking on crutches. A pathological diagnosis of adamantinoma having been made at this time, irradiation was advised. X-ray treatment was given from August 24 to September 12 as follows: 800 R units to each side of the lower part of the leg. The factors were 140 KV, 5 MA, ¼ Cu. 1 Al filter, and 16 inches distance.

Pathological Examination of the Recurrent Tumor: The macroscopic appearance of this specimen was that of a large broken-up mass of soft curetted material, resembling macaroni mixed with clots of blood. Spicules of bone were present in the mass.

Microscopic Examination: There was an infiltrating epithelial growth in a fibroblastic stroma. In the stroma there were multinucleated giant cells, resembling those found in myeloid epulis. The bony shell and stroma apparently played no active part in the neoplasm. An occasional spicule of bone in the stroma was surrounded by giant cells, functioning as osteoclasts.

The epithelial growth assumed various forms. Some areas appeared, at first sight, to be adenomatous or adenocarcinomatous, with acini lined by tall columnar cells (Figs. 8 and 9). (This part of the tumor was not unlike the specimen examined in April 1931, except that the stroma was more abundant and multinucleated giant cells were more numerous. See Figure 3.) Other areas of the recurrent tumor presented irregular anastomosing branching groups of cells resembling somewhat a basal-cell carcinoma. These groups, however, were composed of two types of cells, a peripheral layer of tall columnar cells and a central network of cuboidal, spindle, and stellate cells. The latter cells contained relatively large nuclei, and projecting from their cytoplasm were delicate processes which formed the network. Spaces of varying sizes, ranging from narrow intercellular clefts to well formed cysts, were present in the epithelial network. Larger cysts were surrounded by a closely packed layer of tall, columnar epithelium, identical with the peripheral layer of cells of the groups above described. Apparently, cystic degeneration of the central network, with the peripheral cells left intact, produces adenomatoid or pseudoglandular structures which, when isolated from transitional forms, may be mistaken for true adenomatous tissue. This is particularly true when such cysts are devoid of contents. Many cysts, however, contained a coagulum in which there were degenerated cells and macrophages (Figs. 10, 11, and 12). The areas of this tumor showing the most usual histological characteristics of adamantinoma are illustrated in Figure 13. The epithelial groups assume bizarre forms and some contain cysts. Figure 14 is a higher magnification of the finger-like epithelial processes, showing clearly the cylindrical peripheral cells (embryonal enamel cells or ameloblasts) and the central stellate cells (embryonal enamel-pulp cells). Figure 15 shows epithelial cellular pleomorphism and a distinct mitotic figure.

Histologically, the epithelial structures of this tumor are characteristic of adamantinoma. The clinical history of slow growth for two years before operation and local recurrence two years after operation is also characteristic of adamantinoma. There was no evidence of new growth elsewhere in this patient. Similar tumors of the jaw do not metastasize.

In consideration of the foregoing data, a diagnosis of primary adamantinoma of the tibia was made which, to our knowledge, is the first case to be reported in American literature.

We are greatly indebted to Major Raymond O. Dart, Assistant Curator, Army Medical Museum, Washington, D. C., for the preparation of the illuminating photomicrographs of the higher-power magnification.

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CALCIFICATION IN FAT PADS ABOUT THE JOINTS

BY ALBERT B. FERGUSON, M.D., NEW YORK, N. Y.

Director of Roentgenology, New York Orthopaedic Dispensary and Hospital

Calcification in fatty tissue has been noted and extensively studied in many areas of the body, but the author has not found a report of the clinical recognition of calcification in fat pads about the joints. For this reason the following four cases are reported. In each of them roentgenographic examination revealed a flaky, calcareous mass in the area of a fat pad at a joint. The calcareous particles tended to appear as short rods or dashes, which are believed characteristic of calcification in fat pads at the joints. The particles tended more to nodular character and less to rod-like form, as duration increased. The calcareous mass altered in shape and in relation to the bones on pressure and on change of position in the two cases in which this type of roentgenographic examination was done.

FIG. 1
Case 1. Calcification in fat pad at shoulder.

The fat pad was removed at operation in two cases. In one, of short duration, the calcareous material dissolved in the fixing solution (formalin) and the specimen was fat. In the case of longer duration the fat pad was extensively converted into masses of cartilage, in small areas of which there was ossification.

In three of the cases the onset was dated from a trauma. In the fourth case the patient was not examined until one year after onset and she remembered no injury. In each case

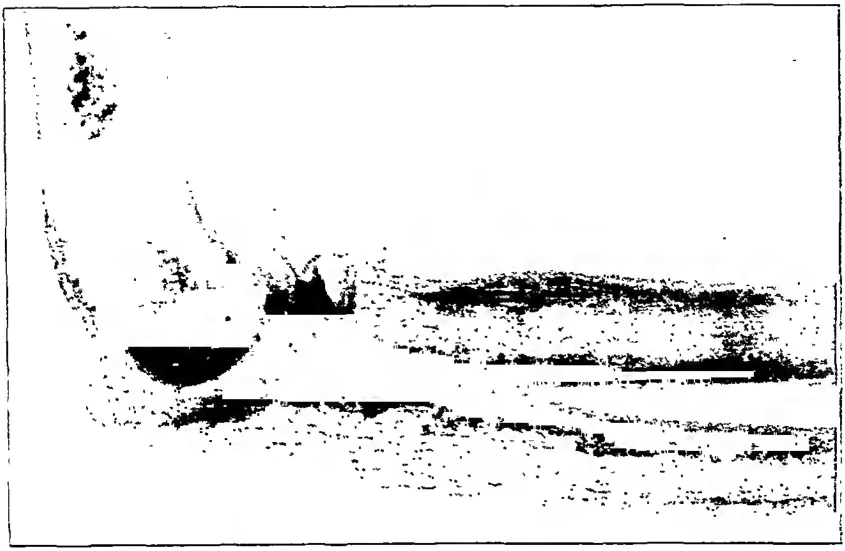

FIG. 2
Case 2. Calcification in fat pad at elbow.

only one joint was affected and the symptoms were mild, consisting of slight limitation of motion and moderate pain on use of the joint or on forced motion.

As two of the cases were proved to have calcification in a fat pad and as the other two appear identical in character, all are believed to have had calcification in a fat pad following trauma. In each case that diagnosis was made because of the tendency of the calcareous material to appear roentgenographically in short rods or dashes.

CASE 1. Female. In December 1925, at age of nine, the left shoulder became painful following severe use of flying rings in a gymnasium. Roentgenographic examination at this time was negative, but pain on extremes of motion and aggravated by activity continued. In October 1927, roentgenographic examination revealed a flaky calcification about the shoulder joint (Fig. 1). In January 1928 the girl came to this Hospital. There was slight fullness about the shoulder anteriorly and inferiorly. Abduction and rotation were slightly limited. There was pain on extremes of motion and after activity. These symptoms and signs have persisted. Roentgenographic examination at this time showed a flaky calcification at the left shoulder inferiorly and about the coracoid process medially and laterally. The mass altered in shape and in relation to the bones on pressure and on change of position. The calcareous material was in small discrete particles, some nodular, others flaky in character. Many of the latter appeared as small rods or dashes up to one-eighth inch long and one sixty-fourth of an inch thick. As symptoms were slight, no treatment was advised.

The girl was last seen in November 1931. Symptoms and signs were as previously noted. The calcareous particles visible in the roentgenogram were more numerous, so that the mass as a whole had greater density but the extent of involvement was not altered.

CASE 2.* Male. In April 1929, at age of sixteen, the boy noted stiffness and some

* This case is reported through the courtesy of David Bosworth, M.D., New York.

pain in the right elbow one week after a fall. These symptoms persisted. On May 5, 1929, pain on motion was severe but there was no swelling or redness. Roentgenographic examination revealed a mass of flaky calcifications anterior to the elbow joint (Fig. 2). The tendency of the calcareous particles to appear as short rods or dashes was very noticeable. On May 6, 1929, the fat pad was removed. The specimen was fatty tissue. The calcareous matter had dissolved in the fixing solution. Roentgenographic examination eleven days after operation did not show the flaky mass previously present, but did reveal a smaller, denser, rather homogeneous calcification in the same area, corresponding in appearance to the post-traumatic calcifications commonly seen about the elbow joint. Symptoms did not recur and in February 1930 there was motion to 125 degrees with normal power and no symptoms, although the calcification noted after operation was still present.

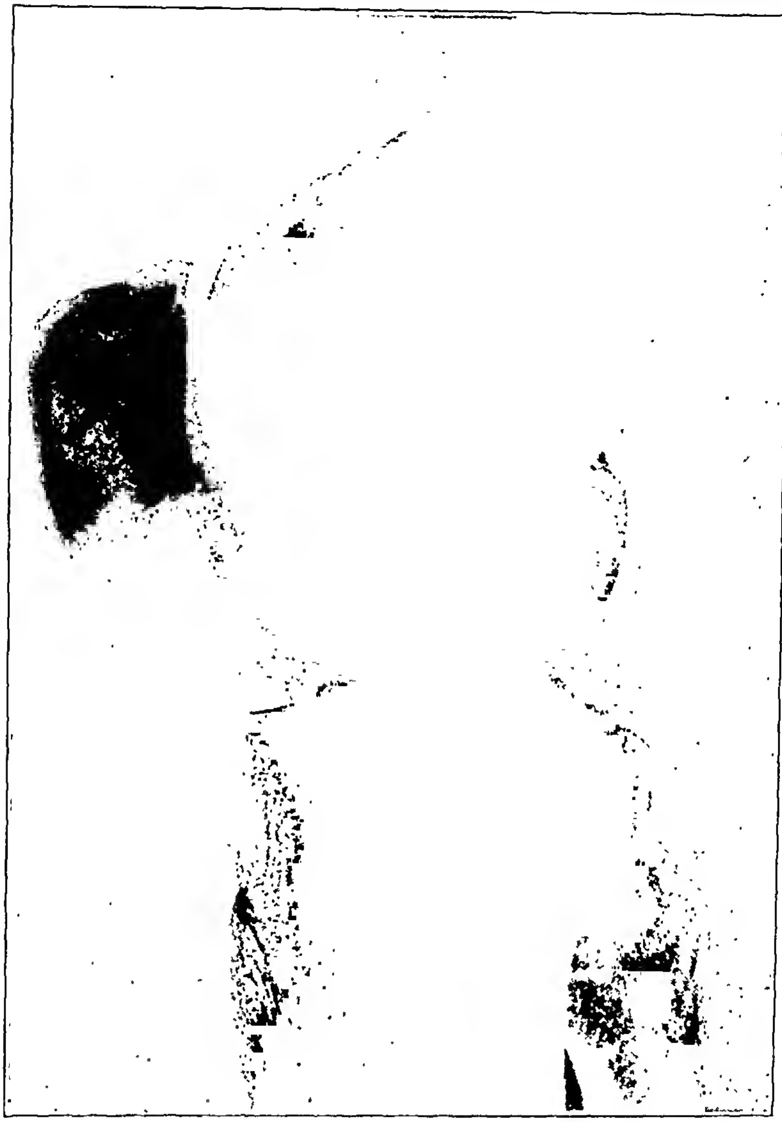

Fig. 3

Case 3. Calcification in fat pad at knee.

Case 3. Female. In November 1928, at age of fifty-eight, the patient fell, injuring the right knee. The knee continued painful and swollen. In August 1929 there was considerable swelling, but no redness nor spasm. Motion was from 170 to 70 degrees, with pain on forced motion and on pressure at either side of the patella tendon. There was some crepitation when the patella was moved. Roentgenographic examination revealed a small, flaky, calcareous mass anteriorly between the femur and tibia, with traces of the same posteriorly and above the patella (Fig. 3). Many of the calcareous particles appeared as minute rods or dashes while other particles were more irregular. A moderate amount of effusion was present in the joint, principally above the patella.

The patient was treated by massage and in October 1929, when she was last seen, the symptoms had diminished considerably.

Case 4. Female. In May 1932, at age of twenty-two, she noted slight pain in

the left knee when walking. This began without known trauma. It gradually became worse. No other joints were involved. The weather did not influence the symptoms. In May 1933 there was slight swelling at the knee. Motion was from 170 to 60 degrees with pain on forced motion. There was tenderness just above the tibial tuberosity. Roentgenographic examination revealed a calcareous mass in the region of the anterior fat pad, with traces of the same posteriorly (Fig. 4). The calcareous particles were mostly discrete nodules or irregular flakes with a few short rods or dashes present. The scarcity of rods and predominance of nodules was believed to indicate long duration of the condition with greater maturity of the calcifications. The mass altered in shape and in relation to the bones on pressure and on change of position. Massage was begun and in June 1933 the calcification appeared less dense. In September 1933 there was much less tenderness, but pain was still present when walking. For this reason operation was advised.

FIG. 4

Case 4. Calcification in fat pad at knee.

The knee was explored September 13, 1933. The synovial membrane was slightly injected but not thickened. Joint fluid was normal. The anterior fat pad contained a large, irregular, cauliflower-like mass of partly calcified cartilaginous material which was brittle and crumbled easily. This mass extended to the anterior attachment of the medial meniscus and the anterior cruciate ligament. A cavity in the upper surface of the tibia anteriorly, two by one centimeters in diameter, contained some more of the cartilaginous material and some of it was also attached to the lower border of the patella. The articular cartilage and menisci were normal, except for a small softened area on the patella and a slightly depressed area on the crest of the medial femoral condyle. Many small pieces of cartilaginous material were free in the joint posteriorly. The knee extended to 170 degrees before the removal of the fat pad and to 178 degrees after the operation. Microscopic examination of the material from the fat pad showed masses of rather cellular cartilage with small areas of ossification scattered through it and traces of fat remaining between the cartilage masses.

Roentgenographic examination after operation revealed traces of calcareous material remaining anteriorly and posteriorly. The patient was given massage, hot applications, and active and passive motion. On October 17, 1933, motion was from 165 to 110 degrees. The patient complained of stiffness of the knee, fatigue on exertion, and ache in the knee at night. By January 16, 1934, fatigue and ache had ceased; motion was from 165 to 100 degrees, with pain on forced motion. She was still under treatment by massage.

FLEXIBLE WIRE AS A LIGATURE CARRIER IN BONE DRILL HOLES

BY NATHAN H. RACHLIN, M.D., NEW YORK, N. Y.

Attending Orthopaedic Surgeon of Beth Moses Hospital, Brooklyn, and The Neurological Hospital, City of New York. Assistant Orthopaedic Surgeon of Kings' County Hospital, Brooklyn

The author has personally experienced, and has also observed in others on numerous occasions, the difficulty encountered in the attempt to carry a ligature through a drill hole. The cause of this difficulty is that the drill hole, if single, is straight; or, if double, is sharply angulated. The curved needle, therefore, can be pushed through only with some difficulty and after considerable loss of time. If one has to repeat the process four or five times—as in an operation for claw-foot—or, in a bilateral case, eight or ten times, the operative delay necessarily becomes considerable.

To overcome this difficulty the writer has utilized a fine flexible copper wire of sufficient length, folded in half to form a loop at the closed end, through which the ligature carrying a threaded needle is passed. After removing the needle, the wire is passed through the drill hole and the free end is picked up at the point of exit and brought to the surface by grasping it with an artery forceps.

The device is of especial value in cases where the mesial end of the drill hole is in a narrow and deep channel, grooved for the purpose of placing and retaining a bone graft.

DEFORMITIES OF THE FOOT ASSOCIATED WITH ARTHRODESIS OF THE ANKLE JOINT PERFORMED IN EARLY CHILDHOOD

BY HENRY TURNER, M.D., LENINGRAD, U. S. S. R.
Professor in Medical Military Academy, Leningrad

A glance at current orthopaedic literature indicates the growing prominence of osteoplastic surgery in every-day orthopaedic practice. Operations on the skeleton are finding increasing new ground for their application, and the nature of the procedures is becoming more ingenious and more complicated. The dawn of these manipulations on bone tissue can be traced back to J. Hunter, who made practical the idea of grafting, and great credit must be given to those who, in the early periods without means of accurate study, have brought bone grafting to the present perfected methods.

The paralytic foot still remains a boundless field of contest in the invention of procedures for restoring its function and efficiency. Between the extreme limits of simple arthrodesis of the ankle joint by removing the cartilage, as originally introduced by Albert, and the elaborate methods of longitudinal splitting of the foot and destroying the tarsal and mid-tarsal joints, are to be numbered the two-joint arthrodesis of Davis, the three-joint operation of Ryerson, the partial removal and reshaping of the astragalus of Hoke, the total astragalectomy of Whitman, and the temporary extirpation of the astragalus by Lorthior. In reviewing the diversity of operations which have been introduced for the purpose of stabilizing a paralytic foot, one may admit that our technique is passing through a period of evolution, in conformity with a better understanding of the problem in each particular case.

Much ingenuity has been expended in working out different methods of extra-articular arthrodesis, especially in its application to the hip joint. The ankle joint, also, has afforded a fertile field for extra-articular arthrodesis, and its accessibility has incited many excursions in this direction, with the various operative procedures which have been advocated in stimulating the growth of bone with the use of a graft.

The primary method of sealing the talotibial and the taloscaphoid joints by osteoperiosteal grafts from the tibia is from Cramer[4]. A denudation of the articular surfaces supplemented the external graft. Cramer's idea has been further developed[17] by the spanning of an osteoperiosteal bridge between the lower ends of the tibia and fibula and the tarsus, and by the use of abutments in the lower end of the tibia and mid-tarsal region. Omitting the discussion of further modifications of anterior fixation, we may criticize the validity of the fundamental idea.

If we acknowledge the deficiency of anterior extra-articular arthrodesis of the ankle joint in early years, we may raise the question of the

Fig. 1

Case 1. Specimen of foot obtained after amputation; medial view. Shows massive graft distorting the growth of the tarsal bones.

rationality of the principle of eliminating this most important element in the mechanism of the foot. Assuming arthrodesis to be in general a mutilating interference, its application should be strictly limited to a reasonable consideration of the practical gain to be obtained, for the functional utility of a foot with a loose mid-tarsal joint may be regarded as inferior to that of an artificial foot.

In considering the positive ground gained in our search for efficient operative methods, there must be observed the undisputed modern trend toward preserving the mobility of the ankle joint and confining the operative procedures to fusion in the tarsal region. This must be regarded as one of the significant achievements tending to preserve an important component of the mechanical apparatus of the foot.

The effect of age on the development of deformity is frequently given insufficient consideration in the clinical investigation and in judging the prospects of the results of operative procedures. It is noticeable in the statistics relative to the end results of reconstructive operations of the foot how very frequently little mention is made of the age of the patient at the time of the operation.

We have had opportunity to observe the results of such operations performed at an early age, and are reporting several typical cases.

Case 1. K. K., a laborer, aged twenty, was admitted to the Military Medical Academy because of disability of the left leg. There was history of poliomyelitis at the age of two, with both lower limbs affected; the left regained considerable function, the right remained completely paralyzed. Scars of the right knee, and especially of the

Fig. 2

Case 1. Same specimen; lateral view. Traces of the fibular graft are seen on the outer malleolus and on the calcaneum.

ankle, indicated some complicated operation which had been performed at the age of five; apparently without improvement, as the leg was unfit for use. Evidently an osteomyelitis of trophic origin developed in the distal phalanges of the two intermediate toes; operations for healing the ulcers had been unsuccessful. There was also a history of repeated attacks of erysipeloid redness of the ankle joint. These attacks subsided after the removal of a metal screw which had been used for fixation of the transplant.

Examination showed a particularly severe calcaneocavus deformity, with upward displacement of the forefoot. The lower ends of the tibia, astragalus, scaphoid, and first cuneiform were entirely solidified. There were trophic ulcers in the region of the distal phalanx of the great toe, and the foot was cold and bluish in color. The patient desired amputation for a suitable prosthesis, which was performed on December 20, 1932.

Examination of the bones of the foot (Figs. 1 and 2) shows extreme deformity, much of which is evidently the result of the early operation. The tibia and fibula show marked atrophy, with forward curving of the tibia. The foot shows a longitudinal line sectioning the lower part of the tibia and continuing downward over the talus and calcaneum, forming a backward convex curve. The direction of the calcaneum is practically vertical; the superior articular surfaces are directed upward and backward, the lower portion of the tuberosity pointing forward. The whole anterior part of the foot, including the scaphoid and cuneiform, is directed upward and flexed to a right angle with the leg. A massive bone bridge spans the space anterior to the ankle joint, and the posterior curved extremity is in contact with the shaft of the tibia and is firmly adherent to it by bony union. The anterior pedicle is ankylosed to the scaphoid; bony masses bind the scaphoid to the first cuneiform and partly to the anterior process of the astragalus. An osseous excrescence overhangs the top of the external malleolus and a superficial vertical ridge of porous bone is seen on the outer surface of the calcaneum; these are the remnants of the external bony bridge made at the time of the early operation. The talotibial joint is ankylosed in the position of dorsiflexion to a right angle. The astragalus is distorted, the head and neck being flexed upward nearly in contact with the anterior surface of the tibial epiphysis. The articular head is ankylosed with a porous bone to the external surface of the scaphoid and to the lower surface of the bridge. The tarsus shows a marked degree of porosity. In other respects there are no gross deformities.

The relation between this particular deformity of the foot and the ultimate effect of the operation performed in childhood is evident. The continued active growth of the metaphysis shifted the original site of the attachment of the transplant to the tibia in an upward direction, while the massive graft, firmly united to the tarsal bones, lagged behind in growth and drew the mid-tarsus into a position of dorsiflexion with slight supination. The pull of the ligaments of the sole of the foot, not used for support, brought the calcaneum into an upright position, with a resulting marked cavus. Subsequent pressure from below, transmitted by the anterior process and the sustentaculum tali, produced an upward bending of the neck of the astragalus with a retardation of the growth of its head, thus markedly distorting this important structure of the tarsus. The mechanical strain produced by the action of the transplant is indicated by the grooves existing on the posterior surface of the tibia, fibula, and astragalus, which can be ascribed to the pressure of the shortened tendons of the posterior muscles.

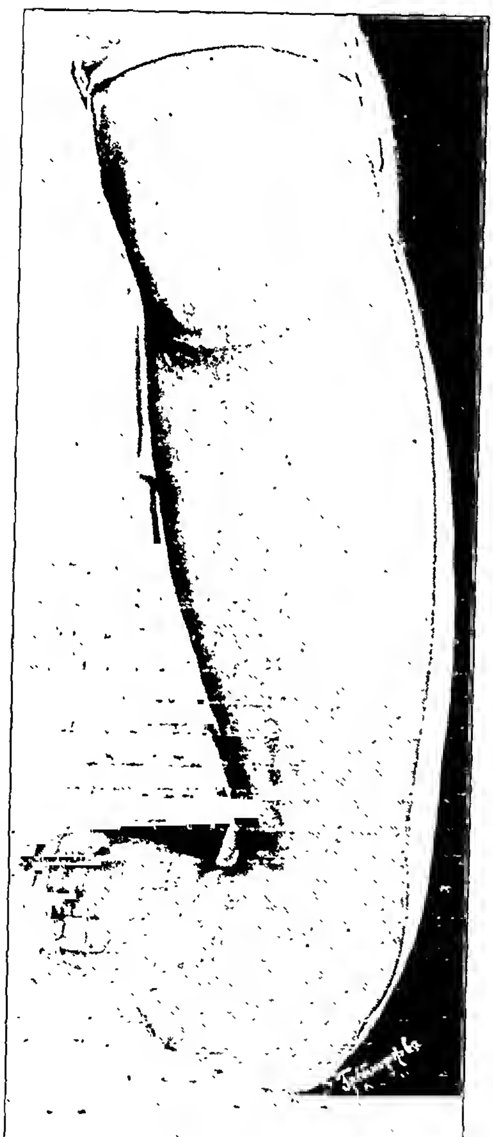

Fig. 3

Case 2. Photograph of a wax cast, showing the clinical appearance of the deformity.

This specimen may serve as a prototype of a definite deformity of surgical production. It could be considered as typical, with allowance for the different grades of deformity in connection with time and durability of the constructed bridge.

Case 2. A. A., a girl, aged fourteen, underwent at the age of two an operation similar to that performed on the patient in Case 1.

The x-ray of the foot (Fig. 4) reveals the basis of the deformity. There is a separation of the distal part of the graft, and the remnants of the outer bridge are loosely attached to the external malleolus. The static disturbance effected by the distortion of the bones is suggested by the atrophic changes of the mid-tarsus which has been excluded from weight-bearing (Fig. 4). These latter findings agree with the porosity of the corresponding part of the tarsus in Case 1.

Another case illustrates the comparative behavior of a free graft taken from the rib.

Case 3, a girl, nine years of age, was admitted to the Cripple Institute on August 28, 1924, with a history of poliomyelitis at the age of two and operation four years later for

the purpose of arthrodesis of the right knee and ankle joint. An autogenous graft by rib had been used for stabilization of the foot. At the time of admission to our hospital the child presented a flexion of the right knee, of osseous character, an equinocavus of the corresponding foot with ankylosis of the tarsal joint, and marked shortening of the right lower limb, especially the thigh, which continued to increase while under our care.

Operative interference was undertaken to correct the deformity of the paralyzed limb, but failed to aid in the adjustment of a prosthesis. As the foot was a marked impediment to the construction of an artificial limb, amputation at the level of the lower third of the leg was performed on October 10, 1931. It is interesting to note that at that time the end of the stump extended only to the articular line of the opposite knee.

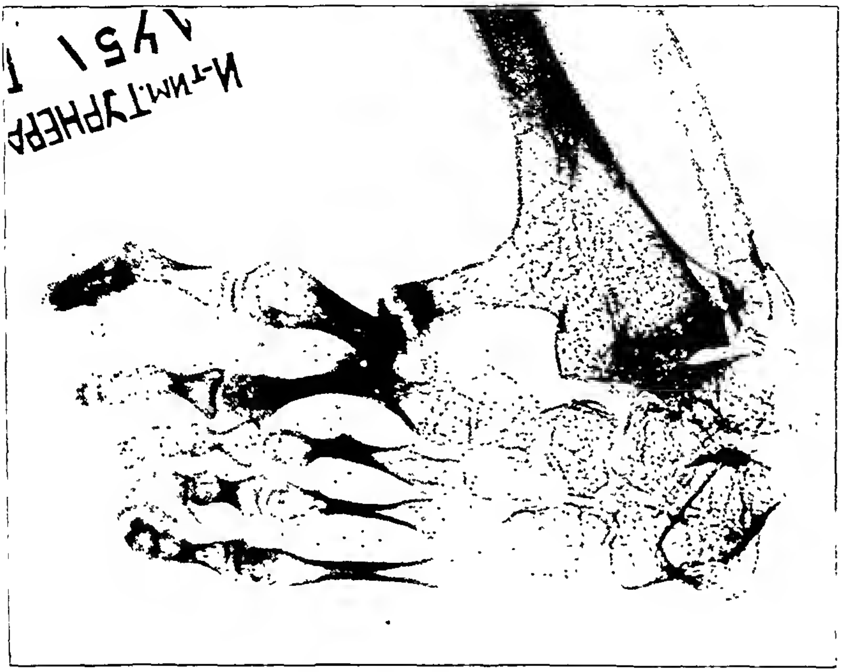

Fig. 4

Case 2. Roentgenogram showing the massive tibia and the remnants of the fibular bridges.

On examination, the skeleton of the foot shows a markedly small, atrophic foot (Fig. 5), the dorsal surface forming an acute angle with the tibia. A line, intersecting the tibia and crossing the astragalus and body of the calcaneum, touches the ground a little posteriorly to the calcaneoplantar tubercles. The anterior portion of the calcaneum and neck and head of the astragalus are turned upward, and the tibio-astragaloid joint is firmly fused in its anterior portion. A few remnants of the rib graft are seen in the form of small rough areas and spike-like excrescences on the anterior surface of the tibial metaphysis. The osseous deposits on the dorsal surface of the fused scaphoid and the two cuboids show a process of osteogenic activity at the other end of the graft, the middle portion of which has had time to undergo total absorption.

In the interpretation of the final fate of the transplant in this case, we may quote the constructive experiments of Müller, whose studies proved that the apparent fracture of a free transplant spanning a joint is due to linear transverse absorption of the graft under the influence of

stress resulting from the movement of the joint. The middle part of the graft, deprived of its osseous bed, is doomed to absorption. The instructive experiments of Verestchinsky[16] in reference to the fate of transplants also confirmed the importance of an adherence of the graft to the cortical layers of the shaft in securing its union and in promoting proliferation. The early absorption of the arch of the osseous bridge in the last case interrupted its deleterious effect on the growing foot. However, it had had time to produce fixed-heel walking, which is associated with operative procedures worked out regardless of the biological factors which would

Fig. 5

Case 3. Specimen of foot obtained after amputation. Remnants of the graft are seen on the tibia and on the tarsal bones.

tend to distort the anticipated final result of an apparently simple plan.

In comparison with the imperfections of an anterior arthrodesis of the ankle joint, a word may be given on the subject of the posterior fusion of this same joint, basing deductions on a series of very limited observations. The anatomy of the posterior portion of the ankle joint presents certain exceptional characteristics which favor the use of mechanical devices. The backward protrusion of the calcaneum facilitates the procuring of building material for the purpose of checking the plantar flexion of the tarsus. In the method of Rokitsky[13], a graft taken from the lower end of the fibula is inserted into the posterior surface of the tibia and calcaneum, the prop thus spanning the tibio-astragaloid and subastragaloid joints. One may question the judiciousness of such a method and also the durability of such construction, because of the influence of pressure as an architectural factor in those devices which are constructed to maintain the integrity of the part and to stimulate the growth of the graft.

An illustration of this is seen in the following case:

Case 4. V. S., a girl of eleven years, with a history of poliomyelitis at the age of two and a half years, was operated on at the age of seven. Arthrodeses of the right knee and both ankles were performed simultaneously.

The roentgenogram of the right ankle (Fig. 6) shows the following results of the extra-articular arthrodesis: The pedicles of the graft indicate a strong fibrous union with their respective beds. Serving as a bow string put upon the stretch by the growth of the tibial metaphysis, the graft produces a compression of the posterior part of the astragalus between the tibia and the calcaneum, and the flattening of the body of the astragalus is distinctly seen in the roentgenogram. The result of the mechanical action of the graft, therefore, may be regarded as inverse to that which has been described as anterior extra-articular arthrodesis of this same joint. In this case the calcaneum is seen to be at right angles to the shaft of the tibia, and the forefoot is in the position of flexion.

In an improvement on this method, introduced by Lissovskaya and Djanelidse[9], a graft shaped like a spear-head, taken from the crest of the tibia, is accurately fitted into the bed prepared in the posterior part of the

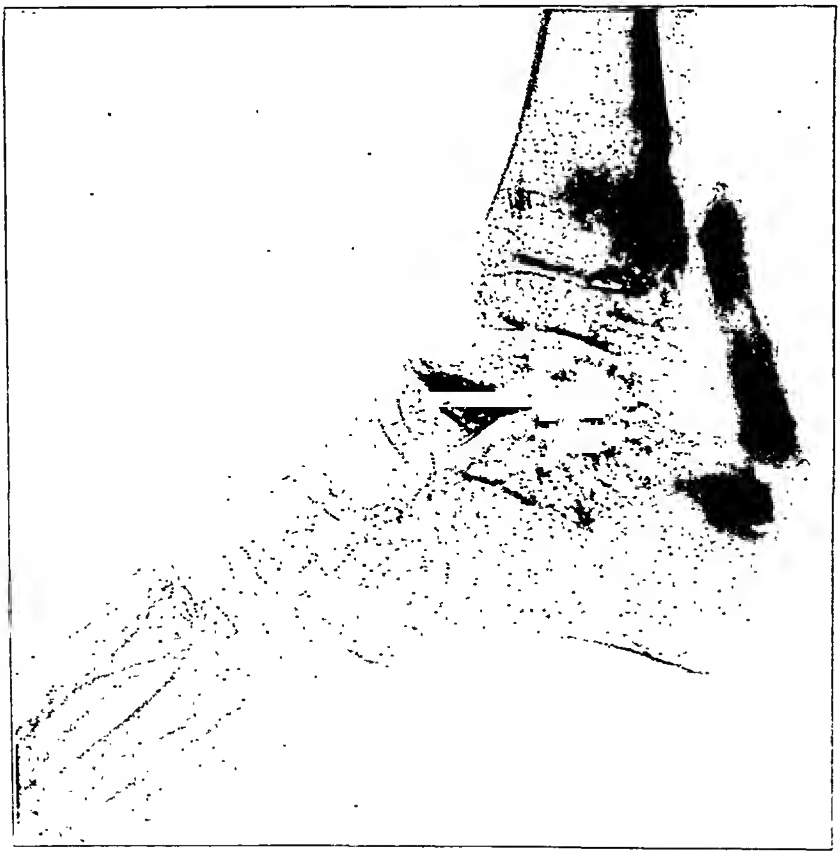

Fig. 6

Case 3. Roentgenogram showing the retarded growth of the body of the astragalus, due to its compression between the tibia and calcaneum through the action of the graft

tibia, astragalus, and calcaneum. The result of this operation on six patients, five of whom were adults and one a child of nine years, was solid fusion of the two joints. The principle of union of the posterior part of the ankle joint is not new, and it is admissible to expect that the transformation of the foot into a solid block will not find a broad application.

Basing our conclusions on the observations relating to operations on the paralyzed foot, it is fair to assume that the measures for restoring its function are at present passing through a process of evolution. Positive achievements have already been made by the recognition of the irrationality of fusing the ankle joint and thereby destroying an important element in the mechanism of the gait, but it has been generally considered that fusing the tarsal and mid-tarsal joints is a very valuable method of improving the function of the foot in weight-bearing.

The effect of growth on the graft is a factor to be considered. "Living tissue cannot be regarded as an inanimate object, which can be molded into various shapes as may be desired without due regard to the physiologic reaction of the organism."[2] This rule holds good for graft work especially. "*Caeteris paribus* the younger the animal", writes Macewen[10], "the greater is the proliferating power of the bone cell, and the longer will it continue to proliferate before it assumes its mature form; consequently, the greater is the ossific production." The same truth is expressed with a tinge of bitterness by Duval[5], who assumes that "*nous oublions presque que l'être vivant, outre son anatomie immuable et complètement connue, a ses réactions vitales, ses fonctions propres que nous connaissons moins bien, et dont nous semblons tenir insuffisamment compte*". The validity of this assumption has been brought home to the writer by observations reported in a previous paper published in 1927.[15]

It has been the author's privilege for many years to be the Director of an institute for physically handicapped children, of approximately 175 beds. The age limit of the cripples of both sexes does not exceed sixteen years. These patients are received from very different sources, many of them having traces of operations performed on account of severe sequelae of poliomyelitis. In the older children we have had the opportunity of following up the results of many early orthopaedic operations, as to the nature of which vague conjectures could be made from the sites and dimensions of the scars. The time of operation in many cases dated back to the early years of childhood. Observations made from these cases offer many testimonials to the error of undertaking operative procedures in too early youth. In some cases, one cannot dismiss the sad impression that the operative undertaking augmented the crippling. The helpless state of the extremities after complex muscle transplanting, or the outstanding grave shortening of the lower extremities after early arthrodesis of the knee and ankle joints, justifies this assumption.

The author hopes that this article may serve as a demonstrative plea for caution in planning arthroplastic operations on patients in early childhood.

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CONGENITAL ABSENCE OF THE EXTENSOR POLLICIS LONGUS OF BOTH THUMBS. OPERATION AND CURE

BY ISADORE ZADEK, M.D., NEW YORK, N. Y.

Congenital absence of a tendon is a very rare condition. The following is the only one of its type that has come under the observation of the writer. It was presented at the meeting of the Orthopaedic Section of the New York Academy of Medicine on October 20, 1933. No one in the audience had seen a similar condition.

The patient was two and a half years of age upon his admission to the Hospital for Joint Diseases, on the Service of Dr. Samuel Kleinberg, on March 29, 1933. He was born with bilateral equinovarus which had been corrected by conservative treatment, but he walked with the feet adducted. This adduction was secondary to torsion of both tibiae and was corrected on April 7, 1933, by performing an osteotomy of the tibiae and outwardly rotating the distal fragments.

In addition to the deformity of his feet, the thumbs presented an unusual condition; they lay helplessly in the palms of the hands. The patient was unable to extend either thumb. There was no history of any paralysis and, in view of the deformities of the feet, it was reasonable to assume that he had a bilateral congenital absence of the extensor pollicis longus.

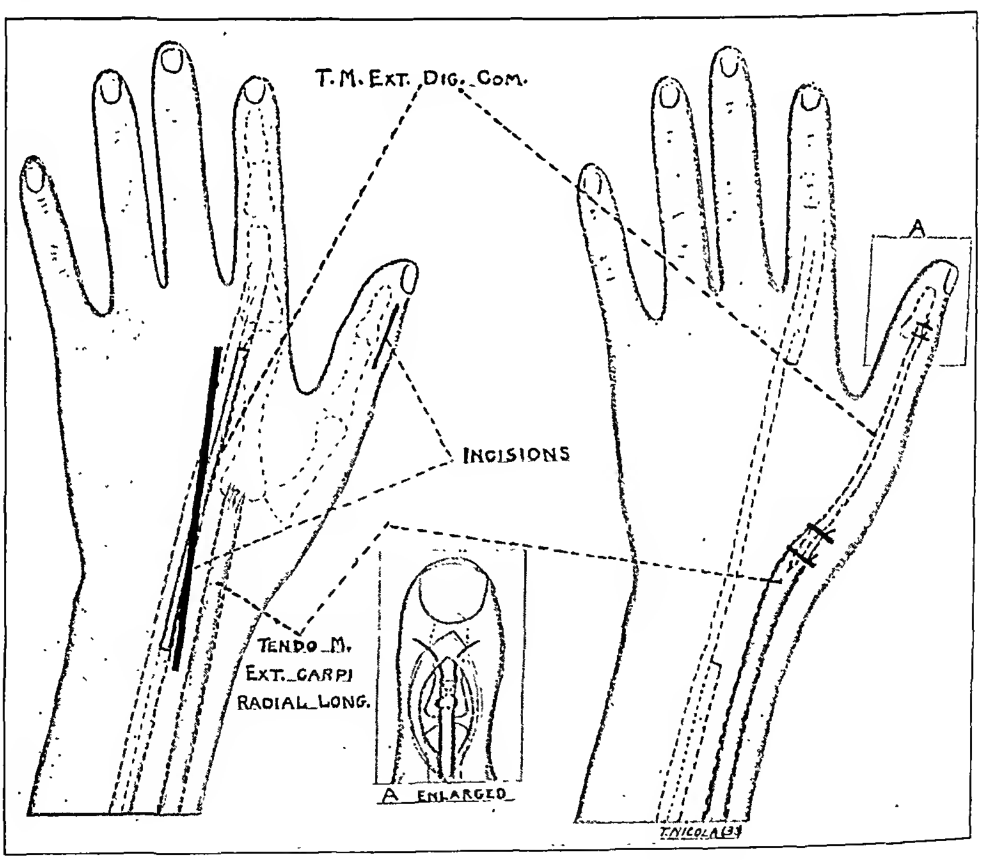

FIG. 1

Drawing to illustrate the steps in the operation.

The left hand was operated upon first, on April 21, 1933. An incision, three and one-half inches long, was made over the extensor surface of the wrist. The extensor carpi radialis longus and extensor carpi radialis brevis were identified. The extensor carpi radialis longus was peeled off at its insertion into the proximal end of the second metacarpal. Further exploration disclosed an extremely attenuated tendon for the long extensor of the thumb, this tendon being about one-third of the diameter of the lead of a pencil. The extensors of the index finger were identified and easily separated into two tendons. A segment, three inches long, was removed from the extensor digitorum communis tendon to the index finger and placed in warm saline.

Next, an incision was made over the dorsum of the interphalangeal joint of the thumb and a bed prepared for the new tendon in the base of the distal phalanx. The segment removed from the extensor digitorum communis was sewed to the distal end of the extensor carpi radialis longus with chromic gut and then passed subcutaneously to the new bed and firmly anchored to the proximal portion of the distal phalanx of the thumb. With a

FIG. 2

Photograph of the deformity of the thumbs prior to operation.

FIG. 3

Photograph made Sept. 27, 1933, showing the result of operation on the thumbs. Patient is able to make a fist, to abduct the thumbs, to adduct the thumbs, and to approximate the thumbs to each finger. His thumbs now function almost perfectly.

small osteotome a flap was turned back on each side of the dorsum of the base of the phalanx. Next a trough was made in this portion of the phalanx and the distal end of the free graft extension imbedded in this groove. The subcutaneous tissue was closed with plain catgut and the skin closed with dermal sutures. No attempt was made to reconstruct any sort of tendon sheath. A plaster-of-Paris thumb spica was applied, holding the thumb in full extension.

The same procedure was carried out on the right hand on May 19, 1933.

Both thumbs were supported in plaster for a period of four months. Toward the latter part of the treatment they were removed from the plasters to permit exercises at times.

It is interesting to note that when the patient first began to extend his thumb he could only do this by utilizing the abductors, which apparently were normal and when the movement was initiated by the abductors he could then begin to extend the thumb. Later he was able to easily extend both thumbs without this initial assistance.

SUMMARY

A case of bilateral congenital absence of the extensor pollicis longus is reported, in which operation was performed, utilizing the extensor carpi radialis longus muscle as a substitute. A free graft was taken from the common extensor tendon to the index finger to add sufficient length to the extensor carpi radialis longus, so that it could be substituted for the absent tendon. The result has been an almost complete cure.

The writer wishes to thank Dr. T. Nicola for the drawing illustrating the operative procedure.

REMOVAL OF A PARATHYROID TUMOR IN A FIBROCYSTIC OSTEOPATHY*

BY LEWELLYS F. BARKER, M.D., BALTIMORE, MARYLAND

The patient to be presented in the Clinic today has been under observation here intermittently for nearly nine years. The history is of more than ordinary interest and is revelatory of the growth of our diagnostic powers in endocrine and metabolic domains during the past decade.

SUMMARY OF CASE HISTORY

Johanna F., a housewife of German ancestry, now sixty-five years of age, first applied for diagnosis and treatment in May, 1925, stating that in 1923 she had had a slight injury and had broken her right arm. Though this fracture of the humerus had healed, the injury was followed by pain in and restriction of movement of the right shoulder. On x-ray examination, it was reported that there was a "benign tumor of the upper half of the right humerus and evidence of the former fracture: no fresh fracture visible". No operation was performed.

One year later, in May, 1926, the woman returned to the hospital stating that a week earlier she had injured the right arm very slightly but "heard the arm crack". This injury was followed by pain, swelling, inability to use the arm, and insomnia. On examination, there was marked anterior bowing and thickening of the right upper arm just below the shoulder, bone crepitus on palpation, and severe pain on attempts at movement. Because of the history of two "pathological fractures" after slight trauma, together with the x-ray findings, it was thought probable that either a giant-cell tumor or bone cyst in the upper part of the right humerus must be responsible. The blood pressure, the heart, and the urine were said to be normal. Accordingly, on May 19, 1926, Dr. Dean Lewis operated, found a large cyst filled with chocolate-colored fluid with only a small amount of solid tissue, and curetted the cavity. The wall and the contents of the cyst were examined microscopically by Dr. M. G. Smith who found a fibrous wall, inside of which was granulation-like tissue containing many multinucleated giant cells; he made the diagnosis of "osteitis fibrosa cystica".

The patient was admitted to the hospital (Surgical Service) for the third time on May 6, 1933, with a third "pathological fracture" of the right humerus, the bone having "cracked" when she picked a coat off the bed and held it out at arm's length to shake it. In the interval between the second and the third admissions, she had suffered from pains in the face, neck, arms, and legs, so severe often as to keep her awake at night. She spoke of the pains as "neuritis" and said that aspirin relieved them. The joints had become stiff and were painful in bad weather. In 1932, she had had her gall bladder removed at Sinai Hospital because of indigestion and severe pains in the epigastrium, symptoms that disappeared after the cholecystectomy.

On examination, in addition to the third fracture of the right humerus, the principal findings included undernutrition (weight, eighty-six pounds), marked anaemia (red blood cells, 2,700,000; hemoglobin, 62 per cent.), brownish pigmentation of the skin, marked kyphosis, arterial thickening with hypertension (blood pressure 165/85, oedema of the back, flanks, and lower extremities, and slight albuminuria; the serum calcium was high (12.9 milligrams per 100 cubic centimeters) and the phosphorus low (2.7 milligrams per 100 cubic centimeters). On account of these findings and the cystic changes in the bones with extensive rarefactions, it was believed that the patient was suffering from hyperparathyroidism, probably due to an adenoma of one or more of the parathyroid glands,

* Clinic to the Senior Students of the Johns Hopkins Medical School, January 25, 1934.

and, on May 18, Dr. Trimble operated in the hope of finding and removing the neoplasm. On the left side no evidence of tumor could be discerned and, on examining the right side, nothing abnormal could at first be seen in the region of the parathyroids. On further search, however, while separating the deep fascia of the neck just below the right inferior thyroid artery, a smooth, glistening, rounded, dark purple hemorrhagic nodule "popped up" in the field, and turned out to be a parathyroid tumor, measuring two and one-half by two by one and one-half centimeters and containing a cyst. On histological examination, Dr. Stafford found it to be a true adenomatous tumor of a parathyroid (not mere hyperplasia).

On the second day after the operation, the serum calcium had fallen to 10.58 milligrams per 100 cubic centimeters and the phosphorus to 2.3 milligrams per 100 cubic centimeters. The patient was closely followed by Dr. James Bordley III, the head of the Resident Staff in Medicine. Because of the falling blood calcium, he ordered calcium lactate by mouth and much milk, in the hope of avoiding a postoperative tetany. As nausea and vomiting developed, the oral administration of calcium was stopped, and, though the Chvostek and Trousseau signs were still negative, some calcium gluconate was given intravenously.

On the third day after operation, the serum calcium was only 7.4 milligrams per 100 cubic centimeters, the phosphorus 2.1 milligrams per 100 cubic centimeters, and on the fourth day the calcium had fallen to 6.07 milligrams per 100 cubic centimeters and the phosphorus to 2.0 milligrams per 100 cubic centimeters. During the next few days, the serum calcium rose a little, reaching 8.2 milligrams per 100 cubic centimeters on the ninth day, though the phosphorus fell still lower (to 1.7 milligrams per 100 cubic centimeters). The non-protein nitrogen was 46 milligrams per 100 cubic centimeters; the blood sugar, 103 milligrams per 100 cubic centimeters; and the carbon-dioxide combining power 22.1 volumes per cent.

On the eleventh day after operation, the Chvostek test became slightly positive, though the Trousseau test remained negative. The patient received 2 grams of calcium gluconate intravenously every day and considerable milk, containing 0.5 grams of calcium lactate in each 100 cubic centimeters, was taken by mouth without producing nausea.

A week later, the Chvostek test became strongly positive, rigidity of the neck appeared, and there was slight twitching of the fingers and of the face, but no definite carpopedal spasms. The intravenous calcium gluconate was continued as well as 10 grams of calcium lactate in milk daily with only slight nausea. The patient's general condition improved somewhat and she was able to be up in a chair, but was too feeble to walk. Oedema persisted; the urinary output was rather low, and the carbon-dioxide combining power remained low. The blood pressure had come down to 140/85.

It was Dr. Bordley's opinion that careful studies of renal function and of the blood protein should be undertaken and that roentgenograms of the kidneys should be made, as he suspected that they might reveal pathological calcification. The patient was accordingly transferred to Prof. Longcope's Service. At this time she became unable to void urine, and had to be catheterized regularly. She also began to vomit frequently again and the vomitus contained no free hydrochloric acid. There was marked abdominal distention. After each intravenous injection of calcium gluconate she would vomit. Intramuscular injections of parathormone were begun on June 11, when she received thirty units at twelve-thirty in the afternoon and thirty units at nine in the evening. The total protein as determined by the refractometer was found to be 1.3468. On June 12, large hemorrhages were found in both retinae on ophthalmoscopic examination.

On account of the complicated situation, Dr. Read Ellsworth recommended cautious continuance of calcium therapy and the administration of twenty units of parathormone occasionally, making the intervals between doses as long as possible, in the hope that the patient's own parathyroids would become more active. It was his opinion that the tetany had been mitigated by the acidosis and by the low serum protein. The blood chlorides had remained within normal limits despite the repeated vomiting. The patient was

given salt solution intravenously occasionally. On account of the low phosphorus content of the serum, twenty to thirty drops of viosterol 250 D were given daily.

The serum calcium during the following week was still very low (5.1 milligrams per 100 cubic centimeters); the phosphorus, 3.6 milligrams per 100 cubic centimeters; the non-protein nitrogen, 68 milligrams per 100 cubic centimeters; and the carbon-dioxide combining power, 33.4 volumes per cent.; and there was but little lessening of the anaemia, the red count continuing to be about 3,000,000 and the hemoglobin 55 per cent. Though the patient's general condition was somewhat better, and she became able to void urine, Dr. Bedell felt doubtful regarding prognosis because of the persistence of the oedema, the hypocalcaemia, the acidosis, the anaemia, and the rising blood nitrogen.

During certain periods, the patient's subjective symptoms underwent marked exacerbation. Thus, on June 21, Dr. French found her irritable, uncooperative, and complaining of headache, a tight feeling in her throat, and the conviction that she would die. These symptoms were associated with a fall in the blood pressure to 118/90 and an exaggeration of the positive Chvostek sign. On parathormone administration, however, there was surprising improvement within a few hours, though on the following day the blood pressure fell to 108/65 and she was worse again, vomited much, and became discouraged and uncooperative. Marked tachycardia appeared, the pulse rate rising at times to 150. The blood calcium dropped to 4.7 milligrams per 100 cubic centimeters. Hydrothorax on the left side was found and drained. After digitalization, giving more parathormone, and pushing the intravenous calcium therapy, her condition improved, so that two weeks later the oedema had largely disappeared. The heart's action had improved; she was able to take 10 grams of calcium lactate daily by mouth; and the serum calcium had risen to 8.9 milligrams per 100 cubic centimeters, though the serum protein still remained near the critical level (1.348).

Early in August, the non-protein nitrogen of the blood rose as high as 72 milligrams per 100 cubic centimeters, the phthalein output was low (only 7 per cent. in two hours) and a two-hourly test of the urine revealed a specific gravity that varied only between 1.005 and 1.010. There were some pus cells in the urine and on urine culture there was a growth of colon bacilli.

As the circulatory insufficiency had been overcome and the serum calcium had been fairly stabilized at a low level (around 6 milligrams per 100 cubic centimeters), the patient, despite her marked renal insufficiency, was permitted to leave the hospital on August 25 with instructions to take ten grams of calcium lactate, one quart of milk, some iron and ammonium citrate and ten drops of viosterol daily.

She was readmitted to the ward on September 8 with symptoms of acute circulatory insufficiency (severe dyspnoea, slight oedema of dependent parts, and bilateral hydrothorax). The blood pressure had risen to 180/120. She was placed in an oxygen tent and digitalization was begun and some theocin was given. The non-protein nitrogen was still high (64 milligrams per 100 cubic centimeters) and the carbon-dioxide combining power was 41.2 volumes per cent. The serum calcium was 5.6 milligrams per 100 cubic centimeters and the phosphorus 5.2 milligrams per 100 cubic centimeters. Under treatment she improved rapidly again. On September 27, two infected teeth were extracted under local anaesthesia.

A roentgenogram of the kidneys, made on October 7, revealed a large irregular area of calcification in the region of the left kidney. Roentgenograms of the bones indicated no increase in lime deposits in the skeleton.

Toward the end of October, the non-protein nitrogen of the blood had risen to 84 milligrams per 100 cubic centimeters, and in early November the phthalein output was 20 per cent. in two hours. There was no improvement in the red-cell count. The colibacillary urinary infection still continued. The administration of iron had to be discontinued as it seemed to nauseate her.

On November 19 she left the hospital again with instructions to continue chronic digitalis therapy and to take 8 grams of calcium lactate daily by mouth.

The patient has been good enough to come to the hospital today in order that I

may present her in person at this Clinic. This forenoon, her condition was carefully rechecked by Dr. J. E. Howard who found her pulse rate 64 and the blood pressure 175/100; though she is still dyspnoeic, there is no hydrothorax now, nor any oedema of the extremities. A first-degree Chvostek sign is still demonstrable, but the Trousseau sign is negative. Studies of the blood chemistry today show: non-protein nitrogen, 62 milligrams per 100 cubic centimeters; carbon-dioxide combining power, 39 volumes per cent.; calcium 5.6 milligrams per 100 cubic centimeters; phosphorus, 4.6 milligrams per 100 cubic centimeters; and plasma protein, 7.25 grams.

DIAGNOSTIC CONCLUSIONS

In view of this history and the many tests that have been made, the main points in the diagnosis at present would seem to be the following:

1. Fibrocystic osteopathy with history of spontaneous fractures and with kyphosis, associated with pains in the face, neck, and extremities and with calcification in the region of the left kidney, all of parathyroid origin due to a parathyroid adenoma, removal of which was followed by hypoparathyroidism with transient tetany, hypocalcaemia, and acidosis.
2. Chronic circulatory insufficiency with arteriosclerosis, enlargement of the heart, recurrent oedema, and hydrothorax, and crises of arterial hypertension.
3. Chronic nephropathy with nocturia, albuminuria, and cylindruria, tendency to fixation of the specific gravity of the urine at a low level, markedly reduced phthalein output, and high non-protein nitrogen in the blood.
4. Moderately severe anaemia (red blood cells under 3,000,000; hemoglobin, 50 to 60 per cent.).
5. Infection of the urinary tract (*bacillus coli*) with slight pyuria.
6. Bilateral hemorrhagic retinitis.
7. Gastro-enteropathy (achlorhydria gastrica (?), some papillary atrophy of the tongue, and a history of chronic constipation and of recurring abdominal distention).
8. Undernutrition.

COMMENTS UPON CERTAIN SPECIAL FEATURES OF THE CASE

The Parathyreopathy and the Calcium Content of the Blood.

Though this patient has evidently had fibrocystic disease and demineralization of the skeleton for many years, it is rather surprising that the hypercalcaemia before the operation for removal of the adenoma was not more marked. The preoperative blood-calcium content of the serum, though higher than normal, did not exceed 12.9 milligrams per 100 cubic centimeters, whereas in many other cases of parathyroid adenoma studied it has been much higher, even 18 milligrams per 100 cubic centimeters, or more.

In addition to the slight degree of the hypercalcaemia before operation, another surprising feature has been the persistence of very low calcium values in the serum since the removal of the tumor. Though a

sharp fall in the blood calcium always follows removal of a parathyroid adenoma and transient tetany is common, it is very unusual to have so marked and so persistent a postoperative hypocalcaemia as has been observed in this patient. Moreover, though the tumor was removed nearly nine months ago, there has as yet been no evidence of remineralization of the bones; whereas ordinarily lime soon begins to be redeposited in the skeleton and this can be easily demonstrated by roentgenograms.

Two possible explanations occur: (1) we may have had to deal with a hypofunction of all the parathyroid glands except that in which the adenoma developed, or (2) it may be that there has been some factor (in addition to hyperparathyroidism) concerned in reducing the basic ion content of the body, a factor that was active before operation and has continued to be active since. I have been wondering whether or not the prolonged acidosis due to the renal disease could possibly have been such a factor in this patient, inasmuch as it is well known that in long-continued acidosis the body may undergo impoverishment in basic ions.

The Circulatory Disorder.

This patient has had a chronic circulatory insufficiency with recurring signs and symptoms of decompensation (dyspnoea, oedema of the extremities, hydrothorax, dilatation of the heart, etc.). The heart is considerably enlarged, and there is a systolic murmur, probably due to relative mitral insufficiency. There have been periods of outspoken arterial hypertension, alternating with periods of lower blood pressure. The palpable peripheral arteries are distinctly thickened. That we have here to deal in the main with an atherosclerotic cardiopathy would seem to be very probable.

The Nephropathy.

The presence of albumin and casts in the urine, the low phthalein output, the tendency to fixation of the specific gravity at a rather low level (between 1.005 and 1.010), and the high non-protein nitrogen content of the blood all point to marked impairment of renal function. These signs, in association with a generalized arteriosclerosis, and with arterial hypertension, make one think of the probability of a renal disease of vascular origin (arteriolar nephropathy).

Another possible factor in the origin of the renal disease should, however, be kept in mind. It is now known that, in hyperparathyroidism, severe injuries to the kidneys may occur (degenerative changes, lime deposits, etc.). To the *American Journal of the Medical Sciences* for January 1934, Albright, Baird, Cope, and Bloomberg have contributed a valuable article upon the renal complications of hyperparathyroidism and have described three or four more or less distinct varieties. Whether or not the lime deposits in the region of the left kidney, observable in the roentgenograms of our patient, are really in the kidney itself or only in its neighborhood, we cannot be sure, since, in hyperparathyroidism, lime

deposits in fatty and other soft tissues within the abdomen not infrequently occur.

It is not improbable that the renal insufficiency in our patient may be partly of vascular origin, partly of hyperparathyroid origin. Because coli-bacillary infection of the urinary tract was demonstrated to exist, some of the medical staff have thought of the possibility also of an ascending pyelonephritic factor.

The Persistent Anaemia.

The red count has not increased under the administration of iron, despite the fact that the anaemia has been presumed to be of a secondary type. This fact, together with the high color index, the papillary atrophy of the sides of the tongue, and the observation that no free hydrochloric acid was present in the vomited stomach contents, should make us keep in mind the possibility of the existence of an atypical Addison's anaemia, even though the spleen is not palpable and no marked anisocytosis has been observed. I think it might be worth while to give hydrochloric acid and ventriculin with the meals and to administer some liver extract parenterally; we should then see whether or not this treatment is more effective than the use of iron and ammonium citrate has been.

You will all agree that we have to deal with a very complex situation. The case is one that cannot fail to be of interest, not only to internists, but also to special workers in orthopaedics, in cardiology, in hematology, in endocrinology, and in disturbances of mineral metabolism. One cannot help but be cautious with regard to prognosis, especially in view of the limited results of the therapeutic measures that have thus far been applied.

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SPONDYLOLISTHESIS IN AN INFANT

BY SAMUEL KLEINBERG, M.D., NEW YORK, N. Y.

Spondylolisthesis, recognized and described about seventy-five years ago, has in recent years engaged the attention of so many surgeons that more cases have been described in the last two decades than in the previous five. Neugenbauer originally described spondylolisthesis as a dislocation of one of the lower lumbar vertebral bodies, made possible by the existence of a congenital defect in the neural ring. This author and others believed the defect to be a congenital lack of osseous fusion. Some writers interpreted the defect as a developmental attenuation and elongation of the laminae, which in the process of growth caused a forward subluxation of the vertebral body. Still other students believed that the displacement was traumatic,—that is, that it had resulted from an injury in which the pedicles or laminae had been fractured. These three theories have, in recent years, been subjected to critical analysis in the light of the pathological anatomy revealed in the living subject at spine-fusion operations, in the cadaver at autopsy, and in both through improved modern roentgenography.

It is now generally believed that the basis for spondylolisthesis is a congenital bilateral osseous defect in the pedicles between the superior and inferior articular processes. Thus the vertebral body and the superior articular processes in front are joined to the inferior articular processes and the neural arch posteriorly only by fibrous connective tissue. The time of the actual dislocation and what occasions it have not been definitely determined. In about half the cases that come to the surgeon's notice there is a distinct history of trauma, which is entirely competent to tear or stretch the fibrous union at the site of the defect and to produce the dislocation. But there are a considerable number of individuals in whom spondylolisthesis is discovered, without any history of provocative injury and even without any symptoms. In these instances it is assumed that such factors as overweight, lordosis, horizontal sacrum, or the cumulative effect of repeated minor traumata, occupational or otherwise, have influenced the production of the dislocation. In this group there is no way of deciding when the deformity appeared. It may have been present at birth. This brings me to the substance and purpose of this communication,—namely, the record of a case of congenital spondylolisthesis.

Baby M., seventeen months old, was admitted to my clinic at the Hospital for Joint Diseases for treatment of a congenital dislocation of the left hip. Nothing unusual was noted in the back, but in a routine x-ray study it was discovered that this patient had a marked spondylolisthesis. The anteroposterior view (Fig. 1) shows, as the arrows (*a*) indicate, a bilateral vertical laminar defect. On the right side the cleft is almost a gap. The lateral view (Fig. 2) shows a forward displacement of the body of the fifth lumbar on the sacrum to a distance of more than half of its anteroposterior diameter. The defect is seen as a linear break (*a*) in the bony substance of the pedicle at the constricted portion.—

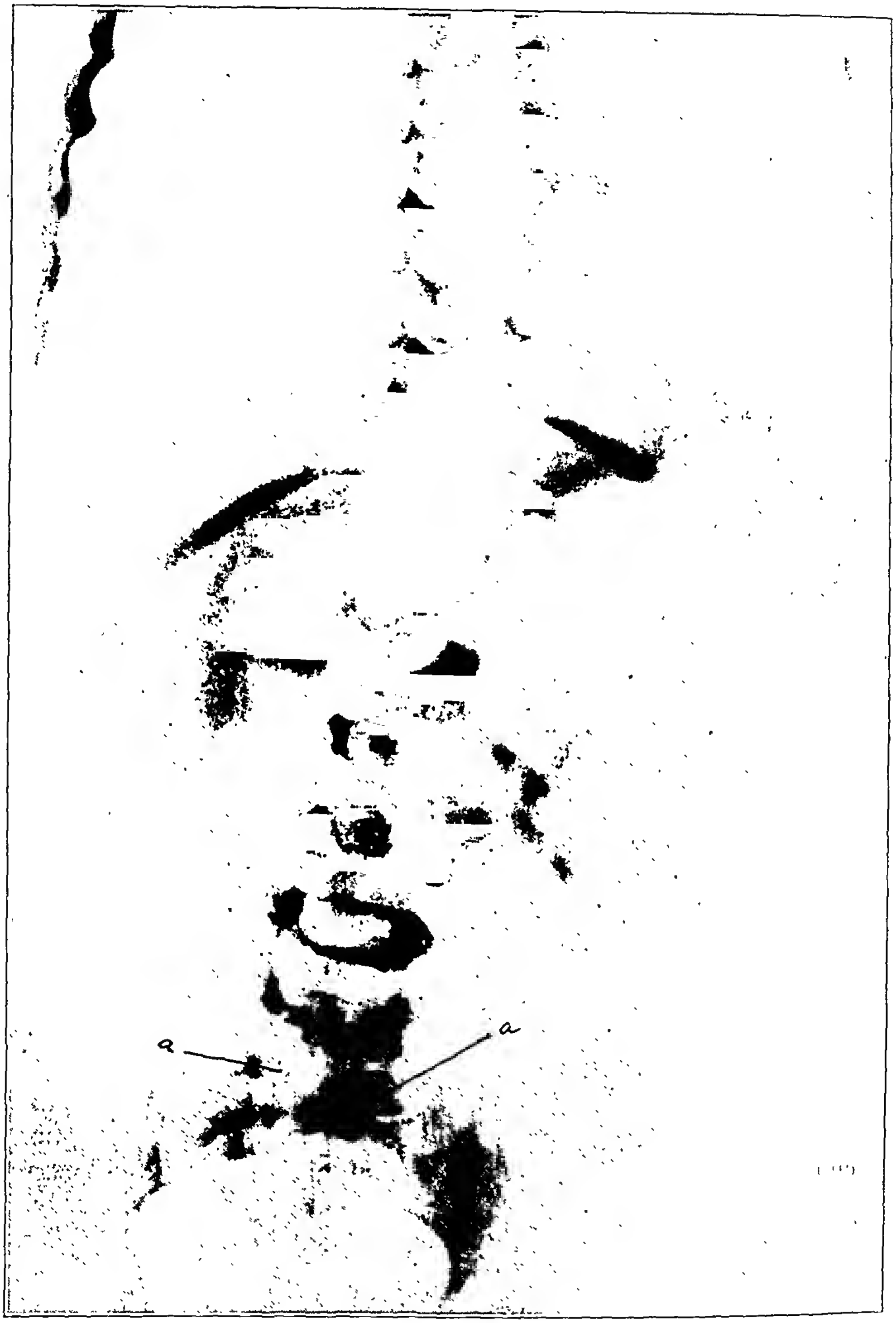

FIG. 1

Anteroposterior view. At *a* are visible bilateral defects in the pedicles of the fifth lumbar vertebra.

that is, at the site of union of the superior and inferior articular processes. This lesion and the identification of its site become apparent by a comparison of the fifth with the other lumbar vertebrae. The long axis of the sacrum is almost vertical, and its superior surface is practically flat, although in spondylolisthesis in the adult it is usually convex. It is noteworthy, too, that the laminae of the fifth lumbar are, judging from the appearance of the other vertebrae, unusually short.

This patient, an infant, not only shows the typical forward displacement of the body of the fifth lumbar vertebra, but also exhibits the characteristic bilateral defect in the pedicles. There is no history of injury, and the infant had been walking only a few weeks; so that the lesion of spondylolisthesis was manifestly present at birth, and may be considered as truly congenital. Up to the early part of last year when I reviewed the literature in preparing an article on "Spondylolisthesis and Prespondylolisthesis," [1] the youngest patient with spondylolisthesis on record was ten years of age. I believed, as did many others, that, while spondylolisthesis undoubtedly depended on a congenital osseous defect in the neural ring, the actual dislocation came after birth, during adolescence or more commonly in adult life, and thus spondylolisthesis was an acquired deformity. But the case here reported throws doubt on such a theory. Here is at least one instance of an actual congenital spondylolisthesis, and it may be that at least some others are also congenital. This concept of a congenital spondylolisthesis is strengthened by the observation that not a few of the patients with this lesion have no symptoms, the lesion having been discovered by accident in a routine physical and roentgenographic study. The study of the case herein described throws some doubt also on the hypothesis of a state of pre- or potential spondylolisthesis, which

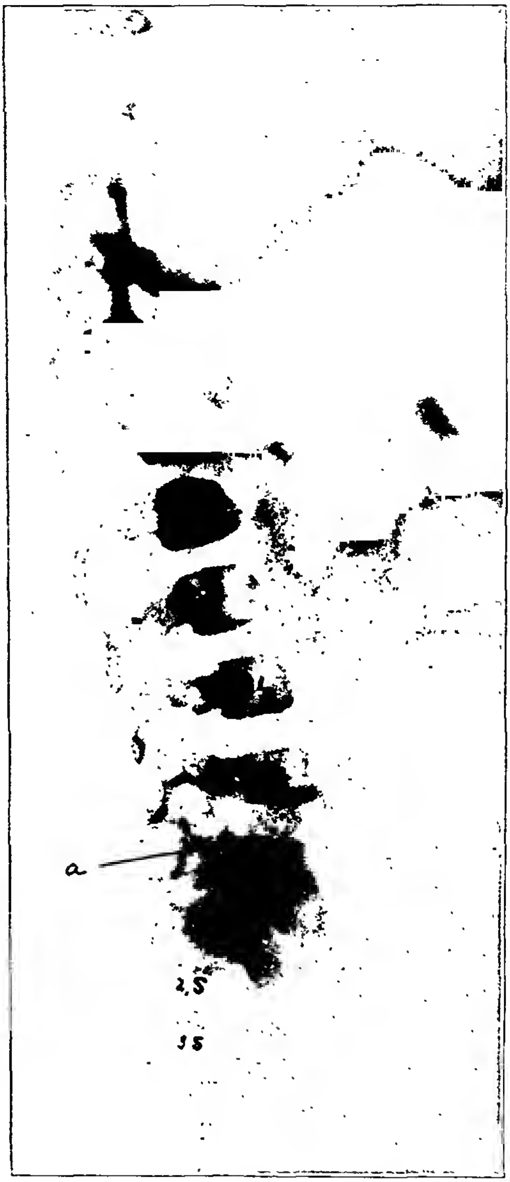

FIG. 2

Lateral view. Note the very marked forward displacement of the body of the fifth lumbar (*5L*) on the sacrum (*S*). The long axis of the sacrum is almost vertical. At *a* is seen the distinct gap or cleft in the pedicle.

was first presented by Dr. Armitage Whitman and more recently emphasized by me in the review of a group of nine cases reported [2] at the Annual Meeting of the American Orthopaedic Association in May 1933, and to which group I have since added several more. All of my cases of pre- or potential spondylolisthesis had laminar defects. More than half of them, having more or less marked symptoms, were operated upon; the presence of the laminar defect was confirmed; and the symptoms were relieved by spine fusion.

The subject of the genesis of spondylolisthesis is, therefore, in a measure still *sub judice*. From the record of even this isolated case it must be conceded that spondylolisthesis may be purely a congenital deformity.

SUMMARY

A case of spondylolisthesis in an infant is herein described. The typical forward dislocation of the body of the fifth lumbar vertebra is present. There is a bilateral defect in the pedicles visible in the antero-posterior and lateral roentgenograms. There are no symptoms referable to the vertebral dislocation. The discovery of this case of congenital spondylolisthesis makes it likely that others are also congenital, and necessitates a more careful and critical study of this type of deformity in relation to its exact onset, particularly in the absence of a history of a definite injury or sudden appearance of subjective symptoms.

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PARATYPHOID OSTEOMYELITIS

A Report of Two Additional Cases

BY J. ROSS VEAL, B.S., M.D., AND ELIZABETH M. MCFETRIDGE, M.A.,
NEW ORLEANS, LOUISIANA

From the Department of Surgery of the Louisiana State University Medical Center and the Department of Surgery of Charity Hospital in New Orleans

Although the majority of all cases of osteomyelitis are caused by the staphylococcus or the streptococcus, it is well to remember that other pus-forming organisms are sometimes responsible for these bone lesions. According to Winslow, for instance, .82 per cent. of all cases of typhoid fever give rise to metastatic bone involvement, while .45 per cent. of all osteomyelitis is typhoid in origin; and Keith and Keith, in a collected review of 18,840 cases of typhoid fever and 700 cases of osteomyelitis, report approximately the same incidence,—.87 per cent. and .43 per cent., respectively.

In view of the very limited number of cases on record, we feel warranted in putting into the literature two additional reports of paratyphoid osteomyelitis.

CASE REPORTS

Case 1. Colored male, aged three years, was admitted February 19, 1933, with a story of intermittent fever, highest at night, for the past two weeks, accompanied by general malaise and "hurting". A week before admission localized pain had developed in both arms, especially about the elbow joints; and five days before admission there had been a complaint of pain in the left thigh, though at no time had there been any external evidence of disease in the affected regions. The previous history was without incident.

Physical examination revealed a negro child, apparently in severe pain and acutely ill. There was marked anaemia. The tonsils were chronicly diseased; but the examination was otherwise negative, except for tenderness and pain on pressure over the entire course of the left femur beyond the joint and slight tenderness on palpation about the right elbow joint. There was no limitation of motion, no visible swelling, nor subjective sense of heat in either the arm or the thigh.

Three days after admission osteotomy was done (ether, Dr. Walter O. Moss) on the lower left femur and the lower right humerus, both wounds being packed with vaselin gauze. The febrile reaction persisted, and saucerization of the involved bones was done May 26 (ether, Dr. Urban Maes), again with no improvement. The temperature elevation persisted, at times reaching 107 degrees, Fahrenheit; and a pyodermia developed, cultures from which revealed staphylococci. Mixed vaccines, injections of citrated blood, a transfusion of whole blood, and other measures were without avail; and the child died on June 26, four months after admission.

Blood count on admission showed: white blood cells 9,950, neutrophiles 61 per cent.: on March 5: white blood cells 16,000, neutrophiles 48 per cent.: on June 24: white blood cells 51,000, neutrophiles 39 per cent., red blood cells 2,460,000. Urinalysis and Wassermann reaction were negative. Repeated x-ray studies of the involved bones revealed typical osteomyelitic lesions; roentgenographic examination of the other long bones, the mastoids, and the chest was negative.

The pus from the first operation revealed a positive agglutination for bacillus paratyphosus B in dilutions 1:50, 1:100, and 1:200, but no agglutination for the A strain or for bacillus typhosus in the same dilutions. Blood culture at this time, as well as a month later, was positive for bacillus paratyphosus B, as was culture of the pus from the bone.

The positive postmortem findings follow:

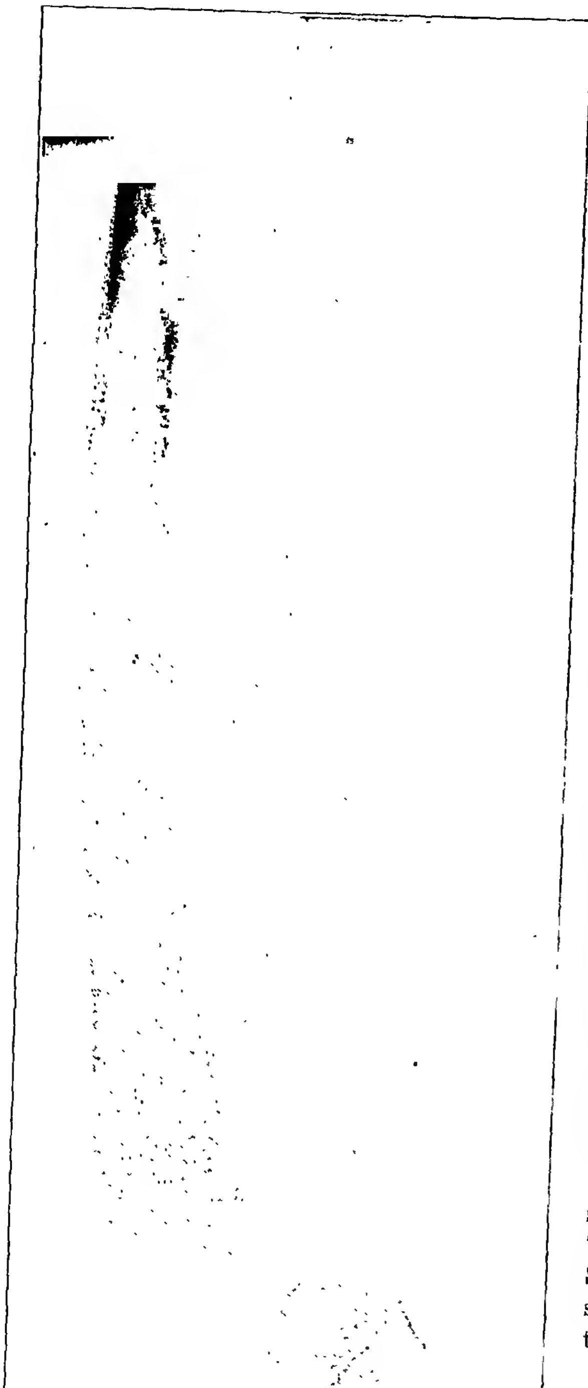

FIG. 1

Case 1. Roentgenogram of left femur showing early elevation and thickening of the periosteum.

"*Anatomical:* The heart and kidneys show cloudy swelling. The spleen, which weighs 150 grams and is slightly enlarged, is purplish-red in color and rather soft. The pulp, on section, is deep red and scrapes away under the knife.

"*Microscopic:* The lungs show an early broncho-pneumonia. The kidneys and liver show cloudy swelling, and there is a marked fatty infiltration of the latter organ. The spleen shows evidence of hemorrhage and congestion, but the typhoid cells usually seen in typhoid and paratyphoid fever cannot be identified.

"*Bacteriological:* Examination of the retroperitoneal lymph glands adjacent to the pancreas and spleen shows bacillus paratyphosus B, while the iliac lymph nodes draining the right thigh show a mixed infection, bacillus paratyphosus B and staphylococcus".

CASE 2. Colored male, aged eight years, admitted April 20, died June 6, 1933. Four days before admission he began to complain of severe pain in the lower third of the right thigh, the middle third of the right leg, and the entire right arm, followed by chills and high fever, which persisted until admission. Constipation had been present since the onset of the illness. For the last three years the child had had repeated attacks of pain in the forearms and the calves of both legs, lasting two to three days and accompanied by local swelling and by chills and high fever. The pain at no time involved the joints. Six months ago a severe backache necessitated medical treatment, but the details of this illness could not be elicited.

Physical examination revealed an acutely ill child, apparently in extreme pain, with a temperature of 103 degrees, Fahrenheit. The positive findings were limited to the tonsils, which were red and injected, and to the right thigh,

FIG. 2

Case 1. Roentgenogram of right humerus after operation, showing advanced osteomyelitis. Note the unusually marked involvement of the central portion of the bone.

which was swollen to twice its normal size. Manipulation of the thigh caused extreme pain, and tenderness, elicited over the whole course of the femur, was most marked over the lower third.

Immediately on admission numerous drill holes were made in the lower right femur (ether, Dr. Felix A. Planche) and a large amount of pus was evacuated. Staphylo-jel was injected into the cavity and the wound was packed with gauze. A slight improvement followed, but within three weeks the temperature had reached its original elevation, a pyodermia had developed, as in the first case, and there was no response to any of the supportive measures employed, including transfusion. A second osteotomy was therefore decided upon, frankly as a last resort, and was performed on June 6, a large amount of pus being evacuated (ether, Dr. Planche). The child did not react from the anaesthetic and died within the hour. Permission for autopsy was refused.

Blood count on admission showed: white blood cells 25,000, neutrophiles 82 per cent. Pus from the bone revealed bacillus paratyphosus B. Repeated x-ray studies revealed extensive osteomyelitis of the lower right femur, not suggestive of any unusual infecting agent. Urinalysis, Wassermann reaction, Widal test, and blood culture were negative.

COMMENT

Typhoid osteomyelitis, while admittedly infrequent, is not usually overlooked, at least as a diagnostic possibility; but infection by the related organism of typhoid, the bacillus paratyphosus, is apparently quite generally ignored. Since the organism of paratyphoid has an affinity for all systems, it is possible for any part or organ of the body to be affected by it, though the bones and joints are only rarely involved. Wins-

low states that, although he saw 100 cases of paratyphoid fever in an epidemic among American troops in Mexico in 1916, no individual, at least at the time of his illness and during his convalescence, complained of any bone dyscrasia; and Webb-Johnson, in 1038 cases, observed only two instances of bone involvement, both of them arthritic.

In 1924 and 1925 Nathan Winslow collected the thirteen cases of paratyphoid osteomyelitis reported in the literature to date, which were distributed as follows: the costochondral junction, four cases (Cushing, Fischer, Rissler, Eschbach); the tibia, two cases (Bushnell, Spassokukzky); the femur, two cases (Jensen and Koch, Ceccarelli); the sternoclavicular junction (Achard and Bensaude); the mastoid (Buchholz); the rib (Emile-Weil); the ulna (Romero); the humerus, the radius, the scapula, both ulnae, and both fibulae in the same patient (Carrington and Davison). Since that date Barco has reported a case of paratyphoid osteomyelitis of the distal extremity of the forearm, details of which are lacking in the only abstract at hand, and Wilensky and Samuels have reported a case involving the sternum. Winslow, in a personal communication, has called our attention to another case of paratyphoid osteomyelitis of the sternum which was reported by Peloquin, Peradon and Vogelin in 1922 and was overlooked in his collected summaries. These cases, with the two we are herewith reporting, bring the total number now on record to eighteen. It should be noted that Achard and Bensaude's and Cushing's cases were reported before the organism of paratyphoid was identified and studied by Schöttmuller in 1900 and again in 1901, and before the division of the group into A and B by Buxtum in 1902. In all the reported cases, except those of Bushnell and Barco, the invading organism belonged to the B group.

It is hard to believe that these cases represent more than a fraction of the incidence of paratyphoid osteomyelitis, since, as in all rare conditions, the majority of cases are not reported, and because of the notorious indifference of many surgeons to the laboratory studies which alone can establish the diagnosis. From them, however, few as they are, certain deductions can be drawn. It is evident that the disease occurs very much more frequently in males than in females, that the age incidence is variable, and that the thoracic bones seem to be most frequently affected. The preceding history is not typical. Most of the reported cases present a history of a febrile period ranging from a few weeks to many months before the onset of bone symptoms, or a definite story of enteric fever, which is usually considered to be typhoid, although the onset of pain may be the first symptom to attract the patient's attention to his condition. In one of our own cases there was a mild febrile illness with malaise for two weeks before bone involvement was apparent. In both instances, of course, the youth of the patients and the ignorance of the parents may have had a good deal to do with the vagueness of the histories. The reported cases, however, as well as our own, make it clear that the process may be quite acute and accompanied by all the usual

signs of acute osteomyelitis, or may be insidious in onset and chronic in its course. The lesions may be single or multiple, but are usually single. Temperature, pulse, and respiration are variable, as is the blood count, exactly as happens when the staphylcoccus or the streptococcus is responsible for the lesion.

The earliest demonstrable x-ray sign, a thickening of the periosteum, is in no way typical. The primary focus of infection is apparently more central than terminal, if we may so express it, the diaphysis being affected primarily rather than the juxta-epiphyseal region. This distinction, however, is a dubious one, especially in adults, in whom the diaphysis is quite as likely to be affected primarily as is the epiphysis. Furthermore, when once the process has gone on to suppuration, the greater involvement of the shaft is naturally not very clear-cut.

Diagnosis, therefore, must be the business of the bacteriologist, and must rest upon the characteristic agglutination tests and upon the identification of the organism from the blood stream or from the discharge from the bone lesion. The agglutination tests, as Stephan points out, are not entirely reliable; though such a case as he reports, that of a patient who, after vaccination against typhoid, developed an apparent paratyphoid bone lesion, is not likely to be encountered very often. In the cases we are reporting the diagnosis was beyond doubt; the agglutination tests were positive, as was the blood culture in one case, and bacillus paratyphosus B was identified in the pus removed from the bones in both cases.

Carrington and Davison's patient died from some undetermined cause two years after the osteomyelitis had been apparently cured; and the patient reported by Peloquin, Perodon and Vogelin died of pleuro-pneumonia, in the course of treatment. There were, as far as can be determined, no other fatalities in the reported cases, and in most of them the patients do not seem to have been critically ill. Both of our cases terminated fatally, in spite of adequate surgical drainage, repeated endeavors to identify new foci of infection, and the use of all possible supportive measures. The marked loss of weight in both children, the development of pyodermia, the low-titer agglutination tests, and other evidences of a lack of resistance to the infection made the fatal outcome not unexpected in either case. Indeed, in the second case the bacteriologist predicted that further surgery would be fatal; but the surgeon, in view of the local conditions present, had no choice but to interfere, for the release of the localized pus was clearly indicated.

While good results have been reported from the use of vaccines in at least two cases in this series (Emile-Weil, Romero), as well as in a doubtful case reported by Emile-Weil and not included in this series, the part of wisdom would seem to be to follow the surgical maxim of providing an exit for pus whenever pus is present. Certainly, if we are to judge from the cases collected by Winslow, that course, in spite of its failure in our personal cases, would seem to be indicated. Perhaps the use of vaccinotherapy as an adjunct to surgery would be a wise precaution in future cases.

SUMMARY

1. To the sixteen cases of paratyphoid osteomyelitis reported in the literature, the majority of which have been previously collected by Nathan Winslow, are added detailed reports of two cases seen personally.

2. A brief note is made of the outstanding considerations of this rare condition as deduced from these reports.

NOTE.—We desire to express our appreciation to Dr. Walter O. Moss and Dr. Felix A. Planche, of the Charity Hospital, House Surgical Service, for their permission to report these cases, and to the members of the Department of Pathology of Charity Hospital for their bacteriological studies.

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* The full list of references in this and succeeding articles by the same author makes a comprehensive bibliography unnecessary here.

PIVOT OSTEOTOMY OF THE FEMUR

BY HUGH E. COOPER, M.D., PEORIA, ILLINOIS

Occasionally it becomes necessary to correct a curvature in the shaft of the femur, the curve being the result of rickets or possibly of the malunion of an old fracture. The deformity in these cases is sometimes so great that not only is it unsightly but also, if not corrected, it will cause gradual damage to the knee joint through the dysfunction of the joint.

The case illustrated is that of an eighteen-year-old girl with a very unsightly deformity of the femora (Fig. 1). A like deformity in the lower legs had been corrected when she was a child of two. At the time of examination there was marked lateral instability of both knees, due to bad alignment, as well as rather advanced flat feet, due to the same cause.

Osteotomy of the shaft of both femora with immediate correction of the deformity is a fairly simple procedure except for the ever-present possibility, especially in older individuals, of the bones slipping at the site of the osteotomy and causing overriding with consequent shortening and even non-union. A number of special osteotomies—V-shaped, curved, etc.—have been described to prevent this eventuality. The method here described is efficient and quite simple.

The patient is placed on the Hawley table, the feet being fastened to the stirrups with the center pin against the perineum. The feet are placed about a foot apart. A cast is applied about the trunk, but extending down only two or three inches onto the thighs. Casts are applied on the lower legs, extending up only to the knees. This leaves the thighs bare for a space above and below the sites of the proposed osteotomies.

Both thighs are now carefully prepared for operation. Before draping, a Kirschner wire is

FIG. 1
Roentgenogram of both femora showing marked bowing.

introduced into the front of each thigh and drilled by means of the wire drill through the femur in an anteroposterior direction (Figs. 2 and 3). This wire may be angled slightly outward to stay away from the vessels and nerves of the back of the thigh. Each wire now extends completely through the thigh. Wire bows are fastened to these wires, each being fastened on the inner side of the thigh. The traction handles of the two bows are now fastened snugly together by adhesive or a small piece of plaster bandage. This absolutely fixes both legs so far as abduction or adduction is concerned.

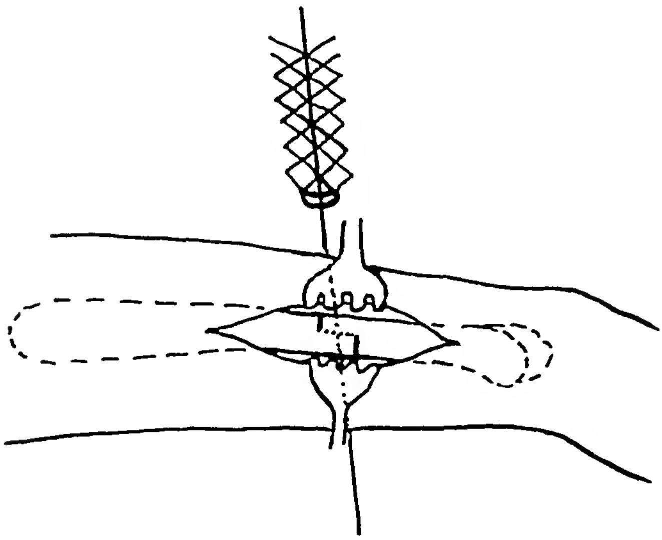

FIG. 2

Line drawing showing lateral view of thigh with incision over shaft of femur. The Kirschner wire is shown passing vertically through the thigh. The two saw cuts are shown on either side of the wire with a row of drill holes connecting them.

The legs are now carefully draped for an incision on the lateral surface of each thigh. A longitudinal incision is made on the lateral surface of the thigh down to the femur, the center of the incision being opposite the point where the wire passes through the femur. By retraction of soft tissues, the wire may be seen passing through the bone (Fig. 2). By means of a small saw, a cut is made in the femur, one-half an inch proximal to the wire from above downward, half way through the bone. A similar saw cut is made from below upward, half way through the bone, at a point one-half inch distal to the wire. A series of drill holes are now made through the bone connecting the deepest points of the two saw cuts. This series of drill holes, placed closely together, so weaken the bone that a slight jar to the leg will cause a fracture, giving a sort of Z-type osteotomy, with the wire extending vertically through both fragments

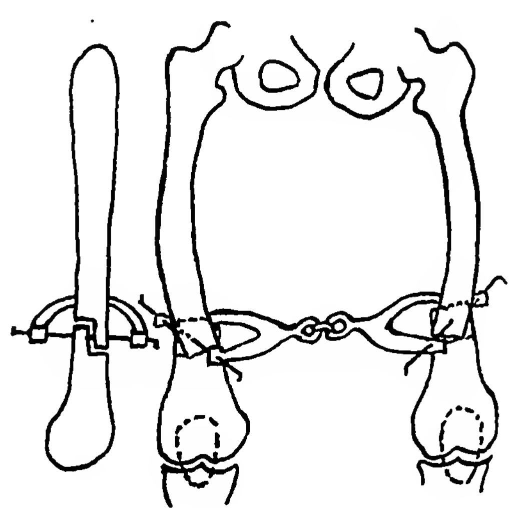

FIG. 3

Line drawings showing the osteotomy in the front and lateral views. In the front view the two wire bows are shown fastened together to prevent any movement of the femora proximal to the point of osteotomy. Both views show how pivoting takes place on the wire.

Fig. 4

A composite x-ray of both legs showing the correction of the bowing. The wires and wire bows are still in position.

(Figs. 2 and 3). The wound is immediately closed and a like osteotomy is done on the other leg. Now it becomes possible, by abducting the lower legs which are fastened to the foot pieces of the Hawley table, to make a complete correction of the bowing, the end of each femur being held firmly by the wire which extends through it (Fig. 4). When the proper correction of each bow has been made, the foot pieces are again made fast. The thighs are covered by sheet wadding, and plaster is applied, covering the thighs and connecting the double hip spica to the leg casts below. A bar is placed across between the legs to give strength to the cast. The patient is put to bed with the wires and bows still in position. At the end of two weeks, the bows and wires are removed and the cast left on until union occurs.

Fig. 5

Photograph showing the patient eight months after the correction.

This method is an improvement on the ordinary osteotomy of the femur for at least two reasons. The rigid fixation of the pelvis, the fixation of the feet on the foot supports, and the fixation of the femora by means of the wire bows fastened together give a very satisfactory mechanical accuracy to the correction of the deformity. The fixation of both fragments on the Kirschner wire eliminates the possibility of overriding with possible shortening or non-union.

THE SCREW-DRIVER EXERCISE AS A CORRECTIVE ASSIGNMENT IN ARM PARALYSIS AS THE RESULT OF POLIOMYELITIS

BY MILTON H. BERRY, VAN NUYS, CALIFORNIA

Director of the Milton H. Berry Institute of Pathokinesiology

The use of a screw-driver as a corrective exercise to reeducate certain muscle groups of the shoulder, arm, and forearm is of definite therapeutic value, especially with children, because of the fact that its use incorporates a "game",—a spirit of contest or conquest that is sometimes difficult to obtain in a routine, resisted exercise.

In the normal use of a screw-driver, the handle is grasped by the hand and fingers as the result of the action of the finger flexors. The wrist is locked by the action of both the hand flexors and extensors. The supinating action of the forearm is made possible through the action of (1) the biceps as a prime mover, and (2) the brachioradialis through the first half of the movement. The forearm is extended as the result of the action of the triceps. The outward rotation of the humerus is the result of the action of the infraspinatus and teres minor, which act more forcibly when the manoeuver is performed with a straight arm.

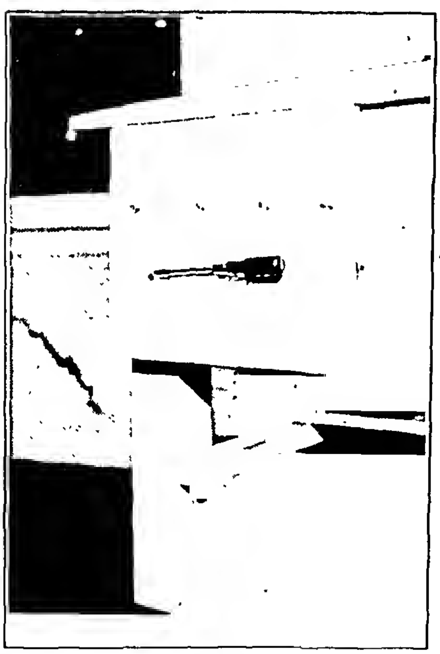

FIG. 1

Beevor was the first to explain the *apparent phenomenon* of the biceps acting as a supinator without flexing the forearm, when it is a prime mover in both movements (which is what occurs in the screw-driver exercise). This is made possible by the action of the triceps which contracts with enough force to prevent the flexion action of the biceps. The result is that the biceps will give true supination. In the screw-driver exercise, however, the triceps also has another function,—namely, that of extending the forearm with enough force to hold the screw-driver in the screw slot.

In arm and shoulder paralysis it is highly important to obtain the maximum salvage from at least four muscles: (1) the biceps, due to the fact that its long head is an important factor in holding the head of the humerus in place in the glenoid cavity, and also because it is a prime mover in the action of supination,—one of the most important and most used movements in every-day life; (2) the triceps, due to the fact that the long head of this muscle is an

Fig. 2

Fig. 3

important factor in holding the head of the humerus in place; (3) the infraspinatus; and (4) the teres minor, due to the fact that these are the only two outward rotators of the humerus, a movement that is most necessary and often used in daily life.

Technique:—A pine board, one inch thick and sixteen inches square, is placed before the subject; upon this board there are twelve or fifteen screws, varying from No. $\frac{3}{4} \times 10$ to No. $2\frac{1}{2} \times 14$ (Fig. 1). The manoeuver is then executed in both the bent-arm and straight-arm positions (Fig. 2 and Fig. 3). The screw is turned "in" when the right arm is involved and "out" when the left arm is involved. The director may also prescribe a pronating or a supinating manoeuver or both, depending upon the muscles involved. However, if there is to be a choice of salvage, it is more important to concentrate upon the supinating manoeuver. Measuring the amount the screw is turned either "in" or "out", from time to time, provides a record of improvement. Larger screws are substituted as increased strength is developed.

RUPTURE OF THE QUADRICEPS EXTENSOR TENDON

A Case Report

BY GASTON A. CARLUCCI, M.D., F.A.C.S., NEW YORK, N. Y.
Associate in Surgery, College of Physicians and Surgeons, Columbia University

It is a well known fact that fracture of the patella is one of the commonest knee-joint injuries, while rupture of the quadriceps extensor tendon is rarely seen.

A perusal of the Bellevue Hospital records for the past ten years shows that during this period 318 cases of fractured patella have been admitted and only four cases of ruptured quadriceps tendon.

This great disparity in numbers is also noted in the literature and very little is found in the text-books regarding this injury.

The case that came under the writer's observation showed such a complete rupture close to the bone that it required fascial sutures to reunite the tendon to the patella, and it is, therefore, reported in detail.

P. S., sixty-five, male, was admitted to Bellevue Hospital March 7, 1932, with a history of having stumbled and fallen two days previous to admission, injuring his right leg. He had been unable to raise his leg since the accident and the knee had become swollen and black and blue.

Physical examination showed a well built man in good general health, with a swollen, ecchymotic knee. Patient was unable to raise the injured leg off the bed and, on attempting to do so, a definite sulcus showed up, just dorsal to the patella. Roentgenograms showed no fracture of the patella.

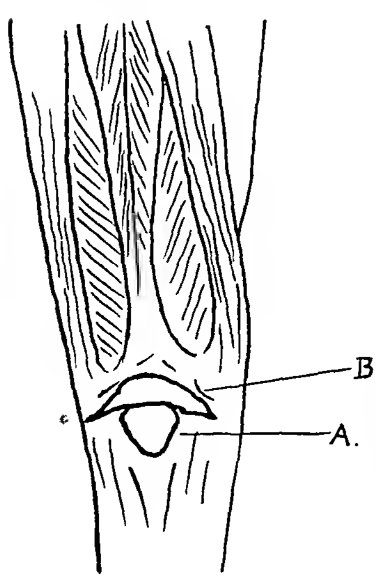

Fig. 1

Diagram of rupture of the quadriceps extensor tendon. *A*. Patella. *B*. Complete rupture of the tendon just above the bone.

Diagnosis of ruptured quadriceps tendon was made and at operation a transverse tear, extending across the whole tendon and including the lateral expansions, was found. The tendon was torn completely off the patella and the tear had gone through the capsule of the knee joint which was filled with blood clots. The separation between the tendon and the patella was at least four centimeters. After cleaning out the knee joint, the ragged edge of the tendon was trimmed, and it was then found that by simple suture only part of the lateral expansions could be brought together. The central portion of the tendon could not be sutured to the patella, as there was nothing to suture it to. Consequently, several strips of fascia lata were obtained from the opposite thigh and used as sutures. Several drill holes were made along the upper margin of the patella and the fascial strips passed through them and then through the tendon in the form of mattress sutures. This procedure brought the tendon firmly down to the bone and then the lateral tears were also brought together by mattress fascial sutures. Thus the rent was closed well, and the skin and subcutaneous tissues were closed with interrupted sutures. A sterile dressing and a posterior molded

splint were applied. The patient was allowed up on the fourteenth day and the splint was removed. The wound had healed by primary union, and the man was immediately able to flex the knee about twenty-five degrees. He had full function of the knee at the end of five months, and this condition had not changed at the end of a year.

It was interesting to note that a culture from the blood clots removed from the knee joint at the time of the operation grew bacterium coli communis. This was difficult to explain for, as far as we could determine, there was no break in the operative technique, the culture was taken under aseptic precautions, and, as previously stated, the wound healed by primary union.

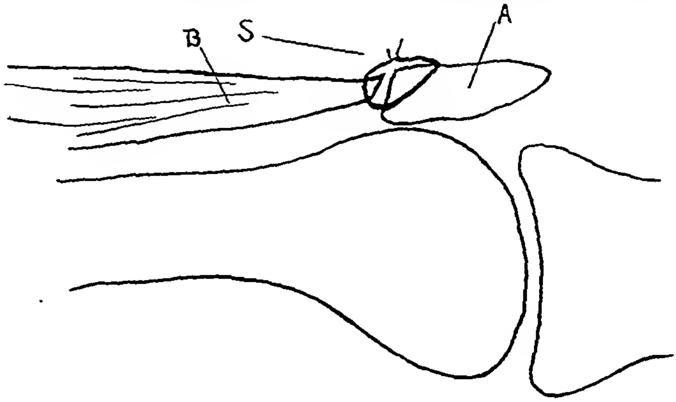

FIG. 2

Diagram of lateral view of the knee joint showing fascial suture, *S*, passing obliquely through drill hole in the upper surface of the patella, *A*, and completely through the quadriceps tendon, *B*.

Speculating on this type of injury, the writer believes that possibly cases of ruptured tendon are often overlooked. Undoubtedly some of the unstable knees that are seen months after an accident may be the result of incomplete tear of the tendon.

A case that came under the author's observation some years ago brought out this point. The patient was a woman, about fifty years of age, who had had an injury to her knee about a year previously. Following that accident, the slightest twist of her knee would absolutely disable her for a week. Finally an operation was done, and the only pathology found was a small lateral tear medial to the patella. This was sutured and the patient regained the full use of her knee and has not had any trouble since.

FIG. 3

Five weeks after operation. Showing nearly complete extension and function of the quadriceps tendon.

It should not be forgotten, however, that in these cases early motion, both active and passive, is essential in order to reestablish complete mobility of the knee.

SUMMARY

Complete rupture of the quadriceps extensor tendon is an uncommon injury. When it occurs, there is total loss of extension at the knee joint.

Apparently this injury occurs only in people well along in adult life.

In cases where the rupture of the tendon has been complete and flush to the patella, strips of fascia lata may be used to close the tear. These strips are passed through drill holes in the upper part of the bone and then through the tendon in the form of mattress sutures.

FRACTURE OF THE HAMATE BONE*

BY HENRY MILCH, M.D., F.A.C.S., NEW YORK, N. Y.

Fracture of the carpal hamate bone is an extremely unusual injury. Stimson barely mentions the fact that Ebermayer observed such a case. The x-ray established the diagnosis of an oblique fracture of the body of the unciform. After forty days' immobilization, the patient was able to return to his work. No statement as to the character of the healing in the bone is vouchsafed. Deimel reported a case of avulsion of the hamular process. The roentgenogram is reproduced, but no mention of the ultimate outcome of the case is noted. Matti recorded three cases observed by: (*a*) Vulpius, (*b*) Steinmann, (*c*) Eigenbrodt. Two cases were reported by Essau. In one, the line of fracture was longitudinal along the ulnar aspect of the hamate bone. In the other, the fracture line was oblique and was directed from above and internally to below and externally. Alban Nast-Kolb cited a case in which there was an oblique fracture of the body. After four weeks of treatment, it is alleged, the patient was discharged without symptoms, though here again no roentgenographic evidence is presented on the matter of healing of the fracture. Albers-Schönberg's patient suffered an obliquc fracture of the ulnar portion of thc body of the hamate bone. Speed reported a case of an oblique fracture of the body. Destot reported a case of his own without roentgenographic evidence and mentioned that Mouchet and Leriche had also seen this type of fracture.

The case herewith reported is of interest not only because of the rarity of lesion, but also because it can be seen that, in spite of what we believe to have been adequate treatment, bony union of the fractured fragments has not occurred.

W. S., white, male, aged twenty-nine, was seen on March 30, 1933, five days after an injury inflicted by the "kicking-back" of the handle while cranking an automobile truck. Immediately after the injury the patient complained of severe pain and inability to move his wrist. Roentgenograms taken at Bellevue Hospital disclosed the nature of the injury and the patient's wrist was immobilized on a plaster-of-Paris splint. In spite of this, the patient continued to complain of severe pain.

Examination disclosed moderate swelling of the fingers, with marked limitation of motion of the fingers. There was slight swelling over the dorsum of the wrist, with moderate ecchymosis. There was diffuse pain over the whole dorsum of the hand, with exquisitely localized tenderness on pressure over the carpal unciform. Pressure along the longitudinal axis of the fourth and fifth fingers caused accentuation of the pain in the region of the hamate bone. The roentgenogram (Fig. 1) showed a fracture of the ulnar styloid process with a fracture of the carpal unciform. The fracture line ran from above and internally to below and externally. The distal fragment was displaced internally and slightly dorsally. Under the fluoroscope, it was noted that the position of the greatest apposition of thc fragments was that of dorsal extension, with marked ulnar deviation of the wrist.

* From the Orthopaedic Service of Dr. H. Finkelstein at the Hospital for Joint Diseases.

FIG. 1

Roentgenogram showing recent fracture of the hamate. Fracture line from above and internally to below and externally.

A plaster-of-Paris bandage was accordingly applied from the heads of the metacarpals to below the elbow joint, with the wrist in the position of choice. At the end of about eight weeks the plaster-of-Paris cast was bivalved and physiotherapy, with gradual active motion, was begun. The roentgenogram (Fig. 2) taken on July 18, 1933, showed "oblique fracture through the carpal unciform, with fair position, marginal sclerosis, and fibrous union of the fragments. Moderate bone atrophy, due to disuse."

Since removal of the cast and the institution of physiotherapy, the patient has noted gradual improvement. The fingers move freely; the pain on pressure over the site of the fracture is disappearing, and the power of the wrist is returning. Slight crepitus on motion can still be elicited. But for the damaging evidence offered by the latest roentgenogram, it might be possible to concur with the other writers on this subject in the opinion that healing was proceeding normally, and assume that bony union had occurred.

From the cases thus far noted in the literature, it appears that the hamate is subject to two types of fractures,—that involving the body of the bone and that involving the hamular process. Except for the roentgenogram, these two types cannot be distinguished from one another. The fracture of the body of the bone may occur through the ulnar portion of the bone medial to the hamular process, as in the cases described by Esau and Albers-Schönberg. More frequently, however, the line of fracture passes lateral to the hamular process. It is always oblique in direction and runs from above and medially to below and laterally. The force resulting in the fracture may be directly applied, as in the majority of cases, or it may be indirect in application, as in the cases noted by Vulpius and Albers-Schönberg. Because of the strength of the intercarpal ligaments, displacement of the fragments is usually not extensive. Slight displacements occur, as in the case here reported. Moderate dorsal displacement of the fragment was noted in the case described by Vulpius, and extreme displacement is not unthinkable, since complete dislocation of the hamate bone has been described.

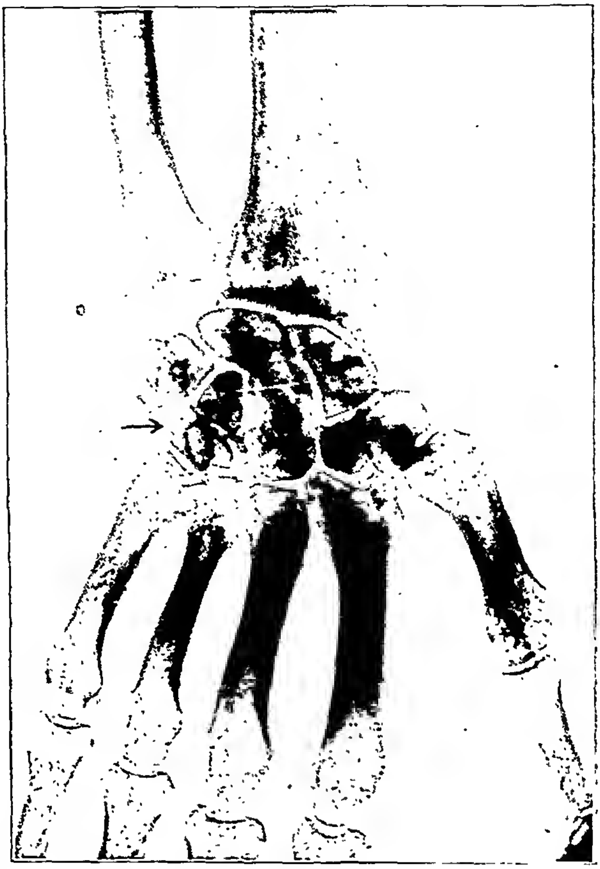

FIG. 2

Roentgenogram taken at the end of fifteen weeks, after eight weeks of complete immobilization by circular plaster-of-Paris bandage. Note the sclerosis of the two fragments along the line of fracture, indicating absence of bony union of the fracture.

The clinical picture, though suggestive, is not unequivocal. After an injury to the carpus, the patient complains of severe pain and disability in the wrist, with loss of power in the hand. There is usually moderate swelling and ecchymosis located mainly over the dorsal and ulnar side of the wrist. Tenderness is localized quite accurately over the distal carpal row, at a spot between the extensor proprius minimi digiti and the slip of the extensor communis digitorum to the fifth finger, as Ebermayer has pointed out. The pain in the wrist is accentuated by the axial application of pressure along the fourth and fifth fingers. The signs are analogous to similar signs described for the diagnosis of fractures of the carpal scaphoid. Crepitus and false point of motion are never elicited and indeed are not to be expected. Occasionally, in fractures of the hamular process, the fractured fragment may be displaced so as to press against the flexor tendons to the fourth and fifth fingers. In such cases, of course, there will be the additional symptom of interference with the flexion of the respective fingers.

The healing of this type of fracture seems still to be a moot question. Speed, in discussing this aspect of the problem, states quite categorically that "this bone tends to heal readily and union can be expected after six weeks". It seems that this statement does not rest on any very extensive basis in fact, because none of the authors whose case reports constitute the sum of our knowledge on this subject has considered the matter, and in none of the reports are roentgenograms or other data of the late results of

the cases offered as reasonable grounds for the drawing of inference. At best, the writers state that, after such or such a period of treatment, the patient was able to return to work. If such evidence were acceptable in the case which has here been presented, the conclusion which might naturally be drawn would be at complete variance with the state of affairs as demonstrated by late roentgenograms. Considering the firm interunion of the carpal elements, it is conceivable that fibrous union or even non-union of the two small fragments might occur with but little clinical disability or symptomatology.

As in many other conditions, the court of last appeal must be the roentgenogram. However, a single negative x-ray should not be accepted as proof positive of the absence of fracture. Where the clinical signs indicate the probability of a fracture, perseverance in exposing the injured part at different angles may be rewarded by the demonstration of a definite line of fracture, which would otherwise have been missed.

The treatment is conservative. Immobilization, either on a plaster splint or in a plaster cast has, in most cases, led to satisfactory results, with the return of the patient to his normal occupation. In cases where the displaced hamular process has caused interference with the function of the flexor tendons, its removal has been advised. Should union not occur in fracture of the body, the question as to further treatment would naturally be presented. Where symptoms and signs of disability are not found, the question of further surgical intervention should not be considered. And even in the event that such symptoms should be present, it is, in our opinion, very problematic whether any operative measures are justifiable. From a functional point of view, the results of excision of any of the carpal bones has left very much to be desired.

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A CASE OF TUBERCULOUS INFECTION OF THE KNEE WITH CLINICAL AND ROENTGENOGRAPHIC APPEARANCE OF CHARCOT'S DISEASE

BY DR. KNUT BENNET AND DR. HARRY HINRICSON, APELVIKEN, SWEDEN

From Apelviken Coast Sanatorium, Robert Hanson, M.D., Physician-in-Chief

In reference to the cases of tabetic knee infection published in an article by Mather Cleveland and Alan DeForest Smith, entitled "Fusion of the Knee Joint in Cases of Charcot's Disease" (*The Journal of Bone and Joint Surgery*, XIII, 849, Oct. 1931), we desire to record a case of tuberculosis of the knee in which the roentgenographic findings, as well as the clinical symptoms to some extent, were such that the diagnosis of Charcot's disease could not be eliminated.

FIG. 1

CASE No. 936/1931, a male, aged forty, formerly a saw-mill worker by occupation, entered the Apelviken Coast Sanatorium in September 1931. He presented a fairly well

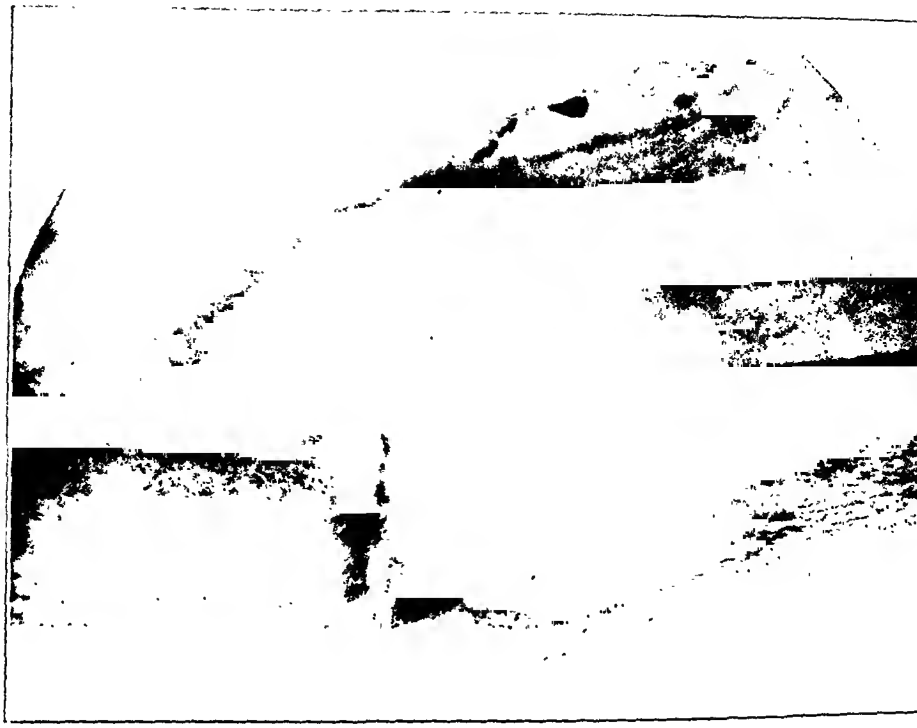

Fig. 3

Fig. 2

marked gibbus of the middle of the thoracic region, as well as some affection of the left knee, and two fistulae near the upper part of the sternum. A brother had had a tuberculous spondylitis; otherwise the family history was negative. At the age of eighteen, the patient had had erythema nodosum. He completed his conscription of military service as "perfectly fit", but is said to have complained at times of fatigue in the back. Later he noticed "a small hump on the back", which subsequently enlarged.

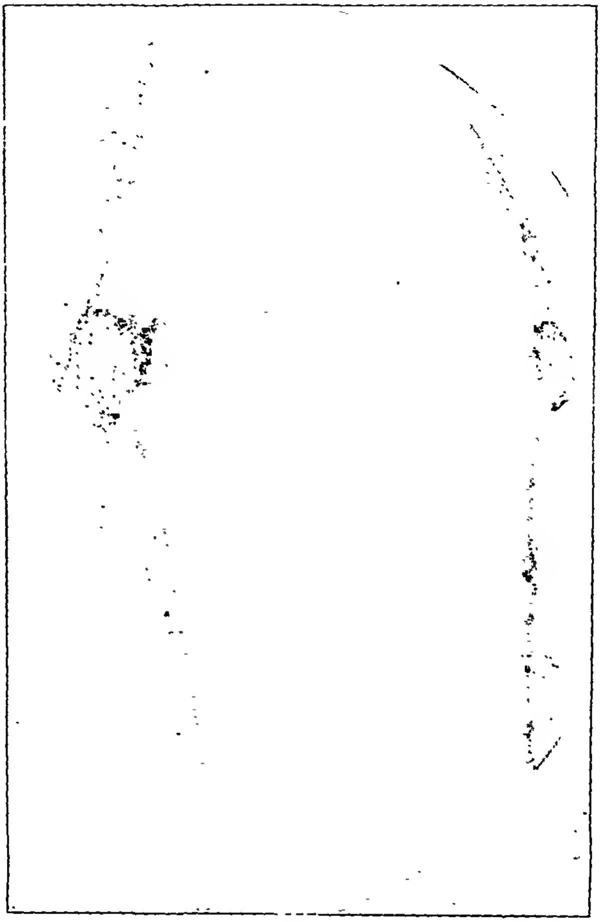

Fig. 4

Ten years ago the left knee began to swell and became painful, particularly at night. At that time the patient changed his occupation, and the pain disappeared, although the limp remained. The back symptoms became progressively worse, and since the age of thirty the patient has been unable to do any form of work. In 1924 he was treated for three months in Äre Sanatorium for tuberculous spondylitis and left tuberculous gonitis. Roentgenograms at that time showed a somewhat diminished calcification in the left knee, normal joint space, and an uneven defect in the lateral corner of the left condyle. The joint surfaces were somewhat roughened, and the breadth of the intercondylar fossa was much increased. In 1925 he applied to the Orthopaedic Hospital in Stockholm, and was given a corset and a jointed knee-cap. The roentgenographic appearance of the left knee at that time was practically the same as in 1924.

On admission to the Apelviken Coast Sanatorium, in September 1931, the patient showed evidence of an involvement of the left knee joint, in addition to the tuberculous condition of the thoracic region and tuberculous sternum with fistulae. The knee showed enlargement and a spindle-shaped form, with a diffusely thickened capsule, but without effusion. The joint was in twenty degrees of flexion, with marked subluxation backward and laterally, and allowed only a small degree of rocking movement in all directions. There was no tenderness on palpation, movement, or walking, and no sinuses or scars of sinuses. Examination of internal organs and nervous system was negative, except that the patient showed some mental disturbance suggesting the simple form of dementia praecox. Lumbar puncture yielded fluid of normal appearance, with no increase in cells and with negative protein reaction. Wassermann reaction in cerebrospinal fluid and blood was negative. Roentgenograms of the left knee joint showed extensive destruc-

tion, with sharply sclerotic borders in the tibia as well as the femur, and several sequestral shadows of striking density, the size of an almond shell (Figs. 1 and 2).

In view of the fact that the roentgenographic findings, together with the total absence of pain, were in favor of Charcot's arthropathy, and in spite of the simultaneous presence of tuberculous infections in other parts of the body, antiluetic treatment was initiated. With a view to improving the prospects of cure with ankylosis, the knee was resected by Dr. R. Hanson. It was then found that the area of destruction disclosed by the roentgenogram was filled with masses containing a number of markedly sclerotic sequestra. In the tibia and femur the destroyed areas were limited by decidedly sclerotic bone. At the back of the femur there was an abscess containing caseous masses and pus-like material. Patho-anatomical examination revealed chronic inflammation of no specific character. Guinea-pig tests were carried out and reported positive (tubercle bacilli found), the diagnosis thus being clearly established.

Since the operation the knee has healed in a normal manner, and with firm ankylosis (Figs. 3 and 4).

EARLY TUBERCULOSIS IN THE HIP JOINT OF AN ADULT

A Case Report

BY S. K. LIVINGSTON, M.D., F.A.C.S., HINES, ILLINOIS

The early recognition of tuberculosis of the hip is uncommon in adult life. For this reason, it is desired to report the following case:

I. G., aged forty-four, was a mechanic by occupation. Advanced active pulmonary tuberculosis, for which condition the patient was hospitalized, had been present for the past three years. He complained of moderate pain and stiffness in the left hip of ten months' duration, which radiated to the left knee and was aggravated by standing and active and passive motion. There was no pain at night and no evidence of muscle spasm.

Examination: The patient stood with a marked increase of the lumbar lordosis. The thigh musculature showed a slight measured atrophy, which on palpation revealed no evidence of induration. There was a flexion deformity of approximately thirty degrees in the left hip with slight adduction and internal rotation and some limitation of motion in all directions, more marked in extreme flexion.

Fig. 1

Roentgenogram April 11, 1932. Early tuberculosis of the hip joint. No evidence of bone destruction. There is some narrowing of the joint space, with thinning of the articular cartilage over the head of the femur and upper border of the acetabulum. The two areas of abnormal density seen at three and nine o'clock are probably calcified glands.

Fig. 2

May 17, 1932. No marked alteration in the appearance in comparison with Fig. 1, with the exception of a slight extension or the beginning of erosion in the region of the ligamentum teres and upper border of the acetabulum.

Fig. 3

July 7, 1932. Evidence of an inflammatory process is shown involving the left hip, characterized by loss of lime salts (osteoporosis) in the region of the articular surfaces, head of the femur, and acetabulum.

FIG. 4

November 20, 1932. Roentgenogram showing erosion of the head of the femur and the contiguous portion of the acetabulum. There is fusion of the head of the femur to the ilium in this region so that the joint space is practically obliterated. Comparison with Fig. 3 reveals a rapid progress of the pathological process.

FIG. 5

March 2, 1933. Erosion of the head of the femur has involved the upper half, also the upper half of the acetabulum.

X-Ray Findings: The early roentgenogram (Fig. 1) "shows no evidence of bone destruction. There is, however, some narrowing of the joint space and some thinning of the articular cartilage over the head of the femur and also on the upper border of the acetabulum. The differential diagnosis at this time lies between infectious osteoarthritis and tuberculosis."

Treatment: The patient was put to bed with traction for a period of three months, during which time the left hip was x-rayed at intervals.

Progress: The progression of the disease may be studied from the successive roentgenograms. In comparing Figure 1 with Figure 5, it will be noted that in Figure 1 there are two small areas of abnormal density within the pelvic wall in the region of three and nine o'clock, probably calcified nodes. Figure 2 shows no marked alteration in the appearance, with the exception of a slight extension or the beginning of erosion in the region of the ligamentum teres and the upper border of the acetabulum. Figure 3 reveals evidence of an inflammatory process, involving the left hip, characterized by loss of lime salts in the region of the articular surfaces, head of the femur, and the acetabulum. This was not definitely exhibited on the previous examination. Figure 4 shows considerable erosion of the head of the left femur and of the contiguous portion of the acetabulum. There is fusion of the femur to the ilium in this region so that the joint space is practically obliterated. Comparison with Figure 3 reveals a rapid progress of the pathological process in the hip. The joint space, which was narrowed in Figure 3, now is obliterated. The articular margins of the femur and ilium show in Figure 3 only a slight degree of erosion as compared with Figure 4. Figure 5 shows considerable erosion of the head of the femur as well as of the upper half of the acetabulum. The appearance is that of tuberculosis of the left hip joint.

Laboratory Findings:

Wassermann and Kahn tests negative.
Red blood corpuscles 5,100,000.
Hemoglobin 90 per cent.
White blood corpuscles 13,700.
Differential blood count:
- Polymorphonuclears 84 per cent.
- Small mononuclears 14 per cent.
- Eosinophiles 2 per cent.

Sputum was positive on six examinations. Temperature range was from 97 to 100 degrees and pulse range from 60 to 100.

DISCUSSION

This case presents certain features in the early diagnosis of tuberculosis in the hip joint of an adult. Of importance are the insidious onset, moderate pain referred to the knee, which is aggravated by active or passive motion, early flexion deformity with adduction and inward rotation, increased pain and atrophy of the thigh as bone necrosis advances.

The primary focus, as usual in adults, is in the head of the femur (Figs. 1 and 2). Evolution of the pathological process is followed by roentgenograms (Figs. 1 to 5). Involvement is first seen as an ill-defined area of necrosis which gradually undermines the overlying cartilage until the joint space is invaded, when there results a gradual erosion of the articular cartilage and adjacent bone. Later in the disease, the contiguous portion of the acetabulum is eroded (Fig. 4).

TILTED HEELS—OR TILTED SHOES

BY EDWARD N. REED, M.D., SANTA MONICA, CALIFORNIA

Placing the wedge, when shoes are to be tilted, next to the lowermost ft of the heel is the common practice of nearly all cobblers who make shoe orrections. "Tilted heels" is a stock phrase; yet it is the *shoe* which eeds to be tilted, and there are serious objections to tilting the heel, espe- ially if it is a heel of any considerable height, as in a woman's shoe.

The accompanying drawings will show the mechanical disadvantage f placing the wedge under the heel; and the more stable mechanics of lacing the wedge above the heel, between it and the upper of the shoe.

When the wedge is placed beneath the heel, thereby tilting the entire eel, the weight line falls toward or through the outer edge of the heel.

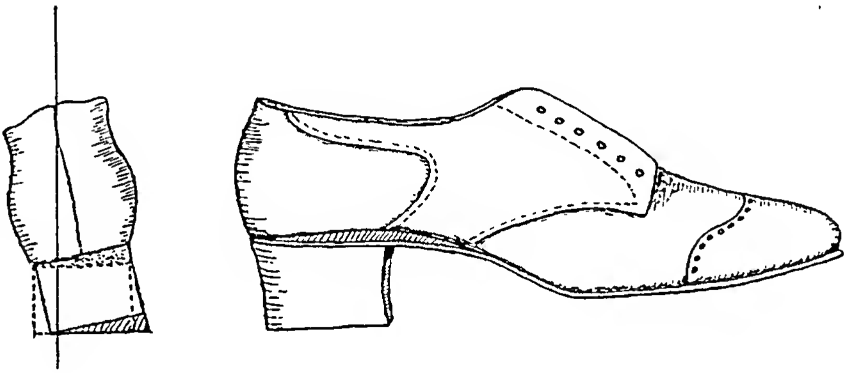

FIG. 1

lmost all the wear occurs in the outer half of the heel, with the result hat the amount of tilting constantly increases each day the shoe is worn. When the tilt increases beyond a certain point, the wearer's heel slides over gainst the side of the counter and part of the weight is supported by the ounter, thereby rapidly ruining the shape and fit of the shoe. The mount of tilt prescribed for a foot should be an optimal one and should emain constant and not continually vary.

It is perfectly feasible, though a little more trouble for the cobbler, o place the wedge between the heel and the posterior end of the sole, lirectly below the rand. The heel is then maintained vertical to the round, in structurally stable relation, and not subject to strain like a 'leaning tower". It will be seen from the drawing that by placing the vedge above the heel, between it and the upper, the whole heel rotates round an axis passing longitudinally through its outer and upper edge, he bottom of the heel being thereby displaced outward with relation to he upper, and as compared with the heel wedged in its lowermost por- ion. The weight-bearing line then falls farther toward the center of the

heel, giving a larger and much more stable weight-bearing surface. The wear then tends to take place more evenly, and the shoe maintains its shape and its hold on the wearer's heel for a longer time.

It is perfectly feasible to place the wedge *above* the posterior end of the sole, between sole and upper, and with advantages which are enumerated in the succeeding paragraph. To accomplish this, the upper is pried away from the sole on the inner edge, over the breast of the heel. Two or three of the nails holding the heel to the sole are cut through. The point of a knife is then inserted between the welt and sole and the stitching cut, forward to about the middle of the shank. The wedge is prepared to extend from mid-shank to back of heel, its thickest point being over the inner front corner of the heel, and skived down to a feather edge anteriorly, posteriorly, and laterally, but of full thickness mesially. The wedge is then inserted and the upper nailed, with several nails introduced under the inner sole, and the stitching between sole and welt restored.

To secure the best results, the insole should be dampened with water or alcohol over the area to be raised. It will then mold itself to the contour of the wedge.

The advantages of this sort of wedging are: that a support has been carried up, not only under the heel, but under part of the instep; the shank has been stiffened; the taper from the heel wedge forward is made very gradual; and an ideal brace is provided for an "orange-peel pad", if such is desired.

TWO CASES OF POSTOPERATIVE SECONDARY TUBERCULOUS DISEASE OF THE SPINE

BY W. E. BROGDEN, M.D., NEW YORK, N. Y.
House Surgeon, First Orthopaedic Division,
Hospital for the Ruptured and Crippled, New York

The important data from the case histories are as follows:

CASE 1. J. H., male, aged fourteen, was admitted to the Hospital January 13, 1933. The chief complaint was pain in the middle of the back and right ribs of four months' duration.

Past history: ordinary childhood diseases. History of familial disease was negative.

Physical examination revealed a well developed male of fourteen years with slight

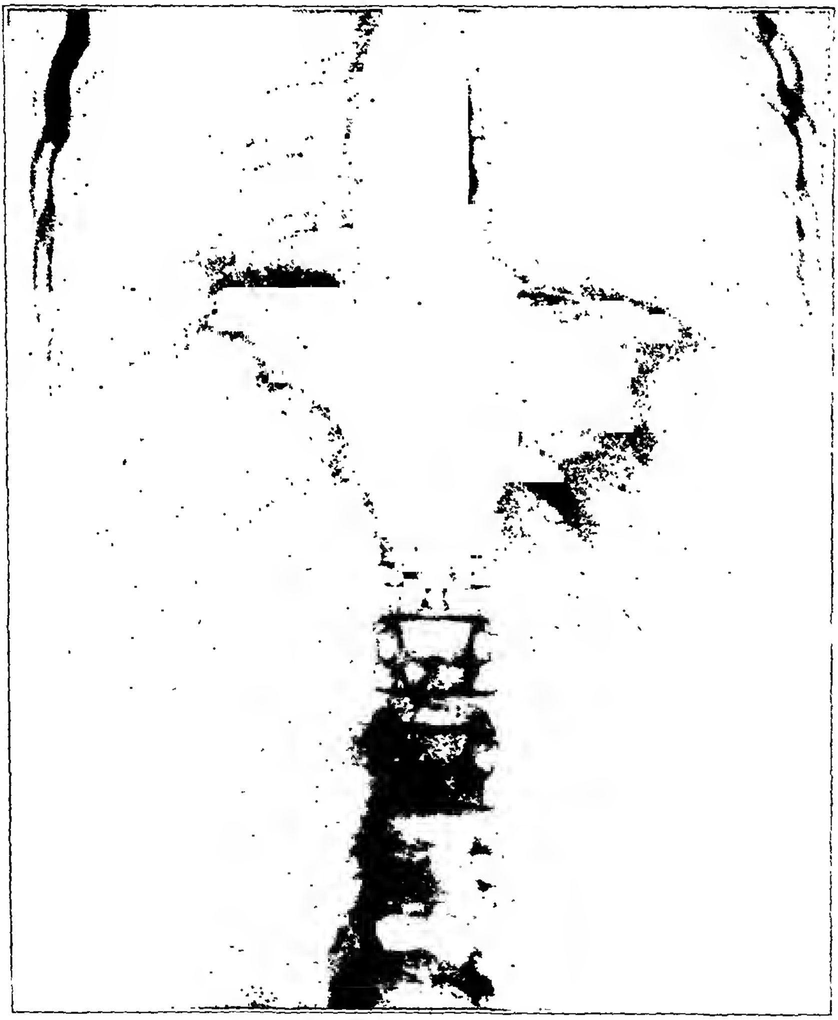

FIG. 1

curvature of the spine and tenderness on pressure over the lower dorsal vertebrae. Head, nose, ears, neck, and throat were negative. The chest was clinically physiological. Abdomen and extremities were negative. Laboratory findings were negative; temperature was normal.

Roentgenographic examination showed destruction of the upper left portion of the body of the tenth dorsal vertebra with loss of most of the disc immediately above (Fig. 1). There was also some destruction of the eleventh dorsal vertebra. Abscess shadows were present. There was a slight sinistrodorsal and dextrolumbar lateral curvature.

Diagnosis was Pott's disease of the tenth and eleventh dorsal vertebrae.

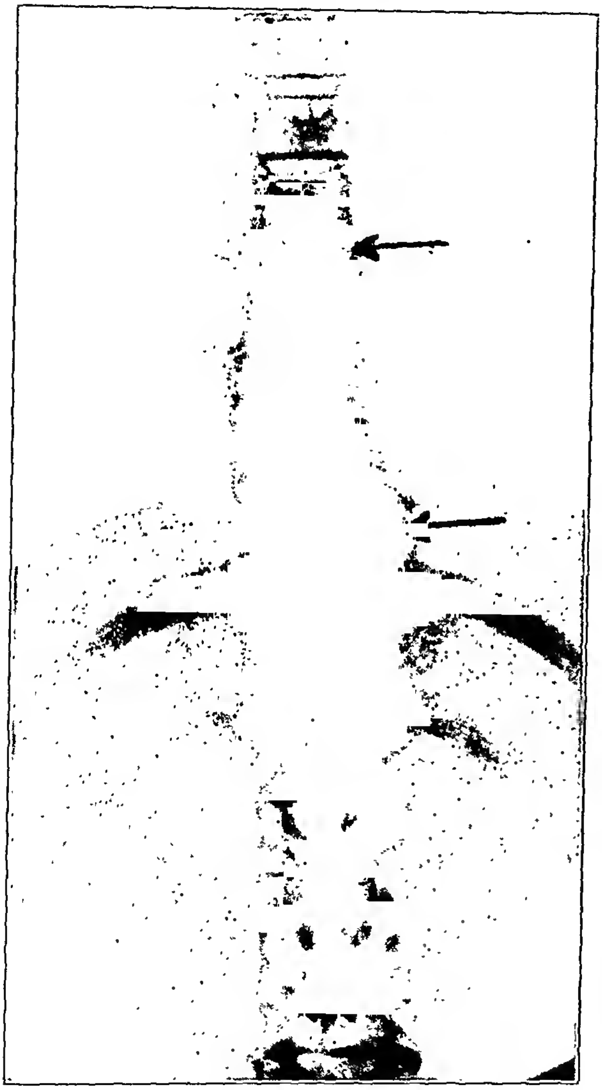

Fig. 2

The patient was placed on a 160-degree convex frame until January 23 when a spine fusion, utilizing the Hibbs procedure augmented by an Albee tibial bone graft, was performed.

The patient made an uneventful recovery and was placed on the convex frame again on February 7. On March 9 a plaster-of-Paris jacket was applied, and on March 12 the patient was discharged, to remain under periodic observation.

Approximately one month later, April 7, the boy returned, complaining of pain in the lower left ribs, the opposite side from where he had had pain previously. The plaster was bivalved and the spine x-rayed. The examination of the films revealed a thinning of the discs between the sixth and seventh dorsal vertebrae (Fig. 2), with a small area of destruction in the upper right portion of the seventh dorsal body; this lesion was in addition to the primary focus for which the spine fusion had been done. On April 10 the previous operative procedure was repeated at the second site. On May 25 x-ray showed tibial grafts in place and no further progress of the destructive process.

Case 2. H. D., female, twenty-seven years of age, single, was admitted to the Hospital on August 26, 1931.

Chief complaint was pain and deformity of the back of two years' duration. Patient had had an abscess of the neck which was incised three years previously; the sinus had drained for one year. She had been treated for "neuritis of the spine" by her physician and, when this had failed, had placed herself in the hands of an osteopath who had treated her for curvature of the spine. When this had failed, she had consulted an orthopaedic surgeon and had been referred to the Hospital.

Family history: negative for tuberculosis.

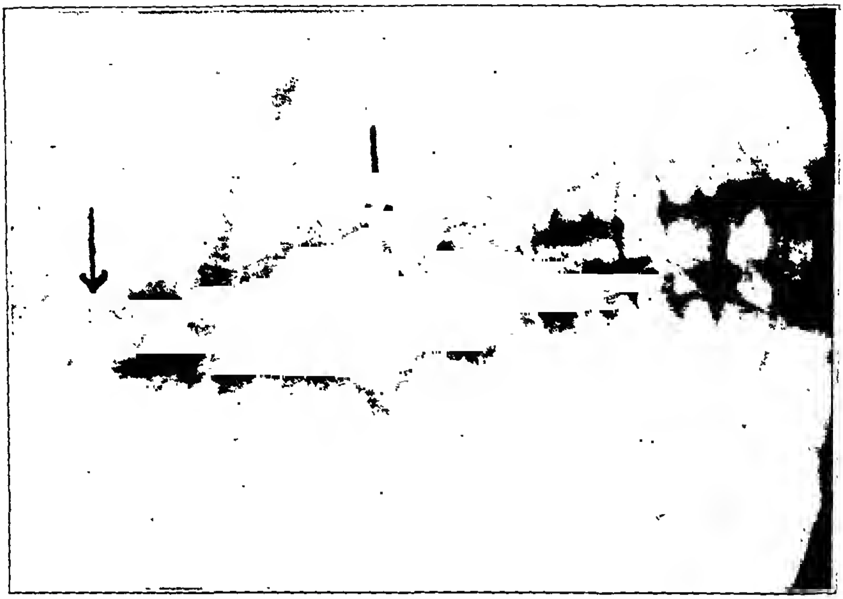

FIG. 4

FIG. 3

Physical examination revealed a well developed female with an angulation deformity in the region of the first and second lumbar vertebrae. Ears, nose, and throat were negative. The neck revealed scars of old sinuses and a few enlarged cervical glands. The abdomen and extremities were negative. Laboratory findings were negative.

Roentgenographic examination (Fig. 3) revealed destructive process of the first and second lumbar vertebrae and an absence of the discs. Chest film showed a healed tuberculosis.

Diagnosis: Pott's disease of first and second lumbar vertebrae.

Spine fusion was performed, using Hibbs's method with tibial graft. Patient's convalescence was uneventful and she was discharged in plaster-of-Paris jacket. Later she wore a Knight spinal brace.

In March 1933 she entered the Hospital again, complaining of severe pain in the back in the area of fusion. Physical examination was essentially the same as two years previously.

Roentgenograms showed the original lesion with graft in place and also a new focus in the bodies of the tenth and eleventh dorsal vertebrae (Fig. 4). Spine fusion was again advised but was refused by the patient.

CHARLES FRANKLIN EIKENBARY

Dr. Charles Franklin Eikenbary died on December 31, 1933, in Seattle, Washington, in his fifty-seventh year.

Dr. Eikenbary attended Miami University in 1897 and 1898; he received his first two years of medical education at the University of Southern California, Los Angeles, and his medical degree at Rush Medical College, Chicago, in 1903. That he took an early interest in orthopaedic surgery was evidenced by the fact that after graduating from Rush Medical College he served as an interne in the Hospital for the Ruptured and Crippled, New York City, where he received his first practical training in orthopaedic surgery. He then located in Chicago, and was associated with Dr. John Ridlon, with whom he worked in the further completion of his orthopaedic training.

In 1904 he married Edna Florence Fisher, of Eaton, Ohio, who survives him. In 1907 he located in Spokane, Washington, and confined his work to orthopaedic surgery. He was a pioneer in this section of the country, and was a distinct factor in the development of this specialty in that portion of the Northwest.

In May, 1917, he entered the World War, first serving with a unit in England and later being transferred to France for duty with the American Expeditionary Forces. While in France he was attached first to the Second, and later to the Eighty-Ninth Division, and served at Chateau Thierry, Belleau Wood, Verdun, and the St. Mihiel Drive. On his return to this country after the Armistice he remained in service at a considerable sacrifice to himself, and for several months spent his time in the Letterman Hospital, San Francisco, among the wounded who had been returned home.

Following his discharge from the United States Army, Dr. Eikenbary returned to Spokane, Washington, in 1919, and resumed the active practice of orthopaedic surgery. He was appointed Chief Surgeon of the Mobile Unit of the Shriners' Hospital for Crippled Children, and at that time took a definite interest in education, as shown by his distinctive service for several years on the Spokane school board.

In 1926 he was made Chief Surgeon of the Children's Orthopaedic Hospital in Seattle, and in this institution he accomplished some of his most outstanding work. He remained in Seattle and was actively engaged both in his private practice and hospital work until his death.

Dr. Eikenbary was a member of many medical organizations, including the American Orthopaedic Association, and he was Chairman of the Membership Committee of this Association during the current year. He was also a member of the International Society of Orthopaedic Surgery. His urge to place orthopaedic surgery on a sound basis was evidenced by his many publications along orthopaedic lines and his interest in the national societies. He always took an active interest in the American Orthopaedic Association, as shown by his attendance at its meetings and the active part which he took in the proceedings, both in presenting and discussing papers.

The success of Dr. Eikenbary as an orthopaedic surgeon was undoubtedly due largely to his capacity for organizing his work in such a way as to be able to take care of a large volume and still give each patient the necessary attention. His conservatism and discreet judgment were safeguards that rendered his services a security to his patients and inspired their confidence. He was particularly devoted to little children and it was a pleasure to see the affection of these children during his visits in the hospital wards or in the out-patient clinics.

His untimely death is a cause of deep regret, coming at the time when he had reached the peak of his professional career and was still capable of doing so large an amount of work. He commanded the respect and affection of all his fellow-workers.

News Notes

The Forty-Eighth Annual Meeting of the American Orthopaedic Association will be held in Rochester, N. Y., June 6 to 9, under the presidency of Dr. Melvin S. Henderson. Mr. W. Rowley Bristow, of London, will be the guest of the Association at this meeting. A full and interesting program is offered and ample opportunity will be given for recreation. The facilities at this medical center will afford a special opportunity for a successful meeting.

The following program has been arranged:

WEDNESDAY, JUNE 6

Morning Session—St. Mary's Hospital Auditorium

9:30—Clinical presentations and case reports by members of the orthopaedic staff of The Mayo Clinic.

Afternoon

2:00—Golf tournament at the Rochester Country Club.

Evening

7:00—President's dinner (informal) at the Rochester Country Club.

THURSDAY, JUNE 7

Morning Session—Plummer Hall

9:00—The Open Treatment of Congenital Dislocation of the Hip.

Selection of Cases for Operation.	Dr. Albert H. Freiberg
Operative Technique:	
Treatment Based on Physiology of Congenital Dislocation of the Hip.	Dr. Steele F. Stewart
The Operative Technique with Some of Its Complications.	Dr. Wallace H. Cole
Late and End Results.	Dr. Frederick C. Kidner Dr. Benjamin P. Farrell

Executive Session

12:00 Noon.

Afternoon Session

1:45—The Open Treatment of Congenital Dislocation of the Hip (*Continued*).

Plastic Operations.	Dr. Frank D. Dickson Dr. A. Bruce Gill
A Shelving Operation by Means of Peg Graft from Tibia.	Dr. Dallas B. Phemister
Some Observations on Results of Shelf Operations in Congenital Dislocation of the Hip, Covering a Period of Thirteen Years. Report of Twenty-Four Cases.	Dr. Frank R. Ober
Bifurcating.	Dr. Rudolph S. Reich
Neck or Shaft Plastic.	
Schanz Osteotomy in Irreducible Congenital Dislocation of the Hip.	Dr. Frederick J. Gaenslen

Evening

Progressive dinner for members and invited guests at homes of Dr. Henry W. Meyerding, Dr. Ralph K. Ghormley, and Dr. Melvin S. Henderson.

FRIDAY, JUNE 8

Morning Session—Plummer Hall

9:00—Treatment of Fractures of the Os Calcis.	Dr. Harold R. Conn
President's Address.	Dr. Melvin S. Henderson
Traumatic Dislocation of the Tendon of the Long Head of the Biceps Brachii.	Dr. LeRoy C. Abbott
Internal Derangements of the Knee.	Mr. W. Rowley Bristow
The Treatment of Acute Purulent Arthritis by Joint Washing.	Dr. Hugh T. Jones
Some Observations on Epiphyseal Displacements at the Upper End of the Femur.	Dr. James W. Sever
Treatment and End Results of Adolescent Epiphyseolysis of the Upper End of the Femur.	Dr. Philip D. Wilson

Afternoon Session

1:45—The Treatment of Calvé-Legg-Perthes Disease.	Dr. Murray S. Danforth
Tendon Fixation in Infantile Paralysis—Late Results.	Dr. William E. Gallie
Traumatic Separation of the Medial Epicondyle of the Humerus in Adolescence.	Dr. John Dunlop
Analysis of Living Cases of Bone Sarcoma After Five-Year Period.	Dr. Willis C. Campbell
X-Ray Studies of the Diaphragm in Children. Correlation with Body Mechanics.	Dr. Lloyd T. Brown
3:45—Visit to the Institute of Experimental Medicine.	

Evening

7:00—Annual Dinner (formal) at the Hotel Kahler.

SATURDAY, JUNE 9

Morning Session—Plummer Hall

8:45 to 11:55—The morning will be occupied by the presentation of a large number of short communications.

Executive Session

12:00—Noon.

The Seattle Orthopaedic and Fracture Clinic, established by Dr. Charles F. Eikenbary and Dr. John F. Le Cocq in 1929, will be continued at 1011 Summit Avenue, Seattle, through the association of Dr. John F. Le Cocq and Dr. Edward Le Cocq.

Dr. Wallace H. Cole and Dr. George A. Williamson have opened their new office at 1360 Lowry Medical Arts Building, St. Paul, Minnesota.

Dr. F. Walter Carruthers has moved his office to Suite 446, Donaghey Building, Little Rock, Arkansas.

Dr. DeForest P. Willard has announced the association with him in the practice of bone and joint surgery of Dr. Jesse T. Nicholson. Their office is at 1726 Spruce Street, Philadelphia.

The Lady Jones Research Fellowship for 1933–1934 has been awarded to Dr. W. S. Creer, Liverpool, who is conducting an investigation into the end results of tuberculous disease of the hip joint treated conservatively and by operation.

The degree of Master of Orthopaedic Surgery, Liverpool, has been awarded to the following:

Dr. Robert William Agnew, Glasgow.
Dr. J. Hamilton Bell, Belfast.
Dr. Joseph Edelstein, Johannesburg.
Dr. Harold Algar Sweetapple, Sydney.

The Liverpool University Gold Medal in Orthopaedic Surgery, which is only awarded in cases of particular merit and which has only been granted twice previously, has been awarded to Dr. J. Edelstein.

The Annual Meeting of the **Milwaukee Orthopaedic Club** was held in February at the home of Dr. C. C. Schneider in Milwaukee. After a round-table discussion of current topics, the following officers were elected for the coming year:

President: L. D. Smith, M.D.
Secretary and Treasurer: C. C. Schneider, M.D.

The **Chicago Orthopaedic Club**, at its Annual Meeting, held on January 19, elected the following officers for the ensuing year:

President: Daniel H. Levinthal, M.D.
Vice-President: F. Seidler, M.D.
Secretary and Treasurer: E. L. Compere, M.D.

The **Czechoslovakian Orthopaedic Society** will hold its Annual Meeting in Prague on June 23 and 24, under the presidency of Prof. Jan Zahradníček. The principal subjects will be "Internal Derangements of the Knee", by Prof. Bedřich Frejka, of Brno, and "Anomalies of the Spine", by Prof. Jan Zahradníček, of Prague. The meeting of last year was postponed and the members attended the Congress in Poznan, Poland.

At the request of the **American Association on Mental Deficiency**, the following notice is inserted:

> The annual meeting of the American Association on Mental Deficiency will be held at the Hotel Waldorf Astoria, New York, May 26 to 29. The Saturday session, May 26, will be given over to the sociological, psychological, and the special educational aspects of the problem in order that local social workers and school teachers may have an opportunity to attend without interfering with their regular duties. The Tuesday afternoon session will be a conjoint meeting with the American Psychiatric Association. Data as to the program may be obtained from the Secretary, Dr. Groves B. Smith, Godfrey, Illinois.

CORRECTION

In the January issue of *The Journal*, page 212, acknowledgment is made by Dr. Chambers to Mr. Hans Christoph, a brace maker, whose skill and interest were of value to Dr. Chambers in perfecting the device described. Since the publication of this article, *The Journal* has learned that at the time this service was rendered Mr. Christoph was an employee of Amsterdam Brothers, and this fact should have been mentioned in the acknowledgment made.

Prof. Herman Albrecht died in Leningrad on December 24, 1933, at the age of fifty-four. Prof. Albrecht qualified in the Medical Academy as a surgeon in 1903, became Assistant in that Clinic, and, after two years of service in the army during the World War, he was appointed Director in the State Prosthesis Institution, which office he held at the time of his death. In this Institution, he received his Professorship. As an organizer of unusual ability and energy, he rendered great service to the cause of the soldiers crippled during the War.

Prof. R. R. Vreden died in Leningrad, February 7, 1934, at the age of sixty-seven. He was graduated from the Medical Military Academy in 1890, and in 1910 was appointed Professar of Surgery in the Medical Military Academy. He was one of the pioneers af the Russian school of Orthopaedic Surgery; and he introduced many original orthapaedic aperations which have been accepted both in the U. S. S. R. and in other countries as well. He showed his interest in surgery through his organization of many meetings and conferences of different scientific associations; he took an active part in these organizations, and also edited surgical periodicals. In his death the U. S. S. R. has lost not only a scientist of the first rank, a teacher and surgeon, but a very humane and kindly physician with a wide popularity and held in great affection among his many patients.

The January issue of *Annals of Surgery* was the Fiftieth Anniversary number, commemorating the services of Dr. Lewis Stephen Pilcher, Editor of this successful journal.

In 1885, taking time from a busy life, Dr. Pilcher originated *Annals of Surgery*, which has been guided continually by him since that date and of which he still is Editor and the active head. Dr. Pilcher has established and developed one of the excellent journals of surgery in the country and it has always reflected the Editor's standard of quality. It is dignified, sincere, and scientific. As the official organ of the American Surgical Association, the New York Surgical Society, and the Philadelphia Academy of Surgery, it has exerted a profound influence on American surgery and has been a standard for other journals.

The medical and surgical public are duly appreciative and grateful to Dr. Pilcher for the service which he has rendered as Editor of this journal.

The Committee of **The Robert Jones National Memorial**, the Earl of Derby, K. G., president, announces its plan to found this Memorial which has for its triple aim the establishment of:

1. A Robert Jones Professorship in the Royal College of Surgeons of England;
2. A Robert Jones Traveling Fellowship;
3. A Robert Jones National Trust, with the object of insuring financial aid for orthopaedic centers or institutions as most needed.

This project is of unusual interest for the remarkable services of Robert Jones during the War made him an international character, in addition to his already international character as an orthopaedic surgeon. It is hoped that the enterprise will meet with the success which it merits.

Contributions should be made to the Honorary Treasurers: The Lord Moynihan, K.C.M.G., F.R.C.S., and A. S. Blundell Bankart, Esq., F.R.C.S., Quadrant House, 55 Pall Mall, London, S. W. 1, England. General communications should be addressed to the Appeal Secretary, Charles Steuart, at the same address.

The Second Annual Meeting of the **American Academy of Orthopaedic Surgeons** was held in Chicago, January 7 to 10, under the presidency of Dr. Willis C. Campbell. A large number of interesting papers were presented and seminars were held, conducted by men of wide experience. This plan afforded an excellent method of discussion and interchange of opinions and ideas. Symposia on several subjects were also presented. Mr. Naughton Dunn, of Birmingham, England, was the guest of the Academy and presented a paper on "Observations on Some Injuries of the Knee Joint".

The following officers were elected for 1934:

President: Philip D. Wilson, M.D.
President-Elect: Frank D. Dickson, M.D.
Vice-President: Ernest W. Cleary, M.D.
Treasurer: E. Bishop Mumford, M.D.
Secretary: Philip Lewin, M.D.
Executive Committee: W. C. Campbell, M.D.
E. W. Ryerson, M.D.
M. S. Henderson, M.D.
S. Kleinberg, M.D.
J. C. Wilson, M.D.

The next meeting will be held in New York, January 14, 15, and 16, 1935.

The readers of *The Journal* are all interested in the effort to establish a practical **Standard Classified Nomenclature of Disease** and are willing to give their aid to those who are earnestly engaged in this work. To this end, is presented the following notice from the representative of the American Orthopaedic Association to the National Conference on the Nomenclature of Disease.—*Editor.*

March 12, 1934.

To the Editor of The Journal of Bone and Joint Surgery:

The committee dealing with "A Standard Classified Nomenclature of Disease" continues to function and is particularly interested in improving the first edition of the nomenclature published in 1933. As a representative of the American Orthopaedic Association to this committee, I should be particularly pleased to receive suggestions from any one who is interested in exact nomenclature, since it is only through the cooperation of numerous individuals that an adequate system can be evolved.

One of the difficult tasks devolving on the committee is inclusion or exclusion of new terms. At present the term "prespondylolisthesis" is being given much discussion. Although sponsored by two well known orthopaedic surgeons, the committee is at present opposed to the inclusion of the term for the following reasons:

First,—it gives an incorrect conception of the pathology of spondylolisthesis. The prefix "pre" connotes a preparatory or previous stage, preceding the actual slipping, known as spondylolisthesis. Such a stage, however, has never been shown to exist. On the contrary, all the evidence thus far presented shows that the essential lesion of spondylolisthesis, namely the failure of fusion between pedicles and laminae, is of congenital origin, and that trauma does not precipitate a slipping but simply a train of symptoms.

Second,—even were the term to give a correct pathological conception, it is teutonically unwieldy and a simpler word should be used.

Third,—wherever possible, the use of a Greek noun with a Latin prefix as in the term "prespondylolisthesis", should be avoided.

Instead of "prespondylolisthesis" the committee suggests that the original terminology of Neugebauer be closely adhered to. He used two terms in describing a congenital failure of fusion of the laminae and pedicles: "spondylolysis" to indicate the condition without slipping, "spondylolisthesis" when slipping was present.

If the readers of *The Journal* care to comment on this matter their opinions will be given due consideration.

140 West 79th Street, New York, N. Y. *Leo Mayer.*

BRITISH ORTHOPAEDIC ASSOCIATION

The Annual General Meeting of this Association was held in Edinburgh on November 24 and 25, under the presidency of Mr. A. S. Blundell Bankart.

I. Calcium and Bone

Mr. D. M. Grieg, Edinburgh, speaking on acute osteomyelitis and repair of fracture, said that bone was at the mercy of its blood supply and was decalcified by the hyperaemia of infection, injury, neoplasm, and disuse. In acute osteomyelitis the liberated calcium was redeposited within the periosteum to form the new involucrum. The operation of diaphysectomy removed the available calcium and accounted for failure of bone regeneration; it should never be performed until the new bone was well developed. Similarly in fractures, calcium liberated from the broken surfaces was redeposited within the fracture hematoma.

Mr. R. I. Stirling, Edinburgh, said that "fracture serum" contained up to thirty times as much calcium as blood serum; the calcium was dissolved out of the bone by the acidity of the serum which attained a maximum after five days, and returned to normal within twelve days. Experimental work showed that metal interfered with this normal acidity; the union of fractures was therefore delayed by plating. Ivory and beef bone did not inhibit acidity; the reaction to stainless steel was not yet investigated. Experiments also showed that union was delayed by any injection of the fracture hematoma or by tearing of its wall; this fact should be considered when treating any fracture by local anaesthesia, early deep massage, or operative reduction.

Mr. R. Watson Jones, Liverpool, said that if it was true that decalcification was due to acidity, the experimental observation that metal inhibited acidity was at variance with the clinical fact that metal (other than stainless steel) always decalcified adjacent bone. The important practical point was that hyperaemia caused decalcification, and, if in a fracture the initial hyperaemia was perpetuated by the repeated trauma of inadequate immobilization, by infection, or by the irritation of metal or ivory, there was excessive decalcification and delayed union or non-union. The only important cause of non-union was inadequate immobilization.

Mr. C. P. Stewart, Edinburgh, said that calcium balance depended on three factors: calcium intake (diet and vitamin-D activity), parathyroid activity (mobilization of calcium from the bones), and the rate of bone-cell proliferation (local phosphatase activity and hydrogen-ion concentration). The three factors were interrelated, but the first was of greatest importance in rickets and osteomalacia, the second in osteitis fibrosa, and the third in Paget's disease.

Prof. John Fraser, Edinburgh, discussing lipoid granulomatosis of bone, said that it was due to an error of lipoid metabolism accounting for excess of cholesterol, which was deposited in blood vessels and led to granuloma formation. Symptoms were due to local pressure effects, and included diabetes insipidus from pituitary involvement, loosening of the teeth, and extensive bone decalcification. The bone condition was to be differentiated from neoplasm and gumma, and responded well to deep x-ray therapy.

II. Congenital Abnormalities

Mr. J. Bruce, Edinburgh, traced the evolution of the foot and said that congenital anomalies of the first metatarsal, including shortening, abnormal varus position, and undue mobility, predisposed to strain of the other metatarsals. Compensation of the increased load caused subperiosteal thickening of the metatarsal shafts (Deutschländer's disease), resulted in metatarsalgia, spontaneous or "march" fracture of the metatarsal neck, and Köhler's or Freiberg's disease of the metatarsal head. The recent calamitous report of a case in which march fracture was mistaken for sarcoma, and the leg was amputated, emphasized the necessity for recognition of these disorders.

Mr. Stewart Middleton, Edinburgh, speaking on arthrogryposis multiplex congenita, said that in this condition the skeletal muscles were replaced by connective tissue, and the resulting muscle shortening caused deformities which were very difficult to correct, but

had little tendency to relapse. Investigation of experimental herds of sheep in which the disorder was inbred showed that the muscles developed normally but underwent secondary degeneration before birth of the lamb. It was therefore an intra-uterine muscular dystrophy, and he suggested for it the name "myodystrophia foetalis deformans".

Mr. Bryan McFarland, Liverpool, said that in human cases there were three objections to the theory of muscular dystrophy: first, there was no progression after birth; secondly, there was rarely any family history; and, thirdly, the condition could occur in one limb, the child being otherwise normal.

Mr. Middleton, in reply to the President, said that there was no evidence of a primary neurological lesion.

III. Sciatica and Low Back Pain

Mr. W. A. Cochrane, Edinburgh, reporting the results of dissection of the lumbosacral plexus and the lumbar vertebrae, pointed out that a high or prefixed plexus predisposed to stretching of the nerves. He postulated that the coincidence of such an anatomical variation with an extra presacral vertebra, or with sacralization of the fifth lumbar transverse process, might explain cases of sciatica.

Mr. Watson Jones said that anomalies of the lumbar vertebrae were rarely found in sciatica, but muscle spasm, lumbar rigidity, and scoliosis were very common. Treatment by spinal manipulation failed in at least forty per cent. of cases, but immobilization by a head-suspension plaster jacket invariably gave relief.

The President said that half the cases of sciatic scoliosis could be cured by manipulation. He had occasionally exposed the interarticular joints by operation, and found the nerve roots to be very closely in contact with the joints.

Mr. Walter Mercer, Edinburgh, described an operation for excision of the fifth lumbar transverse process by an anterior extraperitoneal approach.

IV. Fractures and Dislocations

Mr. H. O. Clarke, Manchester, reported eighty-seven recent fractures of the carpal scaphoid, treated by immobilization for periods up to nine months. Bony union was secured in eighty per cent. of cases. Of ten neglected recent fractures (one to three months' duration) treated conservatively, only one united by bone. In such cases he advocated refreshening of the fractured surfaces by operation followed by prolonged immobilization. If the fracture remained ununited, arthritis of the wrist, which could not be relieved by any operation, invariably developed.

Mr. Alan Todd, London, advocated excision of the whole proximal row of carpal bones for old ununited fractures with arthritis of the wrist.

Mr. N. Dott and Mr. Stirling, Edinburgh, advocated manipulative reduction of congenital dislocation of the hip, but said that repeated manipulations impaired the end result. In cases when the upper lip of the acetabulum was underdeveloped, they made a new lip by open operation at an early age instead of waiting for redislocation.

Mr. J. W. Struthers and Prof. Murray Drennan, Edinburgh, and Mr. W. H. Trethowan, London, also reported interesting cases.

The British Orthopaedic Association is planning a particularly attractive program for its Spring Meeting which is to be held in Holland on April 12 to 14, under the presidency of Mr. Harry Platt.

On Thursday, April 12, there will be papers and demonstrations at Leiden: on Friday, April 13, at The Hague; and on Saturday, April 14, at Amsterdam. Plans are being made to take advantage of the exceptional facilities offered in Holland for excursions to museums and to the country. By invitation of Dr. Murk Jansen, the dinner will be held at "Meerrust", Warmond, on Thursday evening.

Current Literature

Surgery of the Sympathetic Nervous System. By George E. Gask and J. Paterson Ross. London, Baillière, Tindall, and Cox, 1934.

The time is ripe for an authoritative and comprehensive survey of the present state of our knowledge in this field of surgery. Gask and Ross have most happily filled this gap with the publication of the excellent monograph under review.

Commencing with a concise but succinct review of the anatomy and physiology of the sympathetic nervous system, the authors proceed to discuss the application of sympathectomy to (1) disorders of the circulation; (2) disorders of the visceral motor mechanism; and (3) the relief of pain.

In the section on circulatory disorders, there is an excellent discussion upon the selection of cases suitable for operation. The use of Sir Thomas Lewis' hot-air chamber as a means of producing vasodilatation by the release of vasospasm seems excellent and new in the clinical field. The various types of operation upon the sympathetic nerve trunk and ganglion are adequately discussed and illustrated. The shortcomings of Royle's operation of ramisection are rightly stressed and ganglionectomy is advocated in its place.

In the section on disorders of the visceral motor mechanism, the discussion of the complex part which the sympathetic nerve plays in controlling the movements of the gastro-intestinal and the genito-urinary tracts is excellent. Due consideration is given to the work of Leriche. Periarterial sympathectomy is reviewed. The results which follow this operation are sometimes so excellent that the procedure should not be entirely abandoned even though the present state of our knowledge does not permit us to understand how they can occur.

The section on the relief of pain considers the value of sympathectomy for certain types of dysmenorrhoea, for vesical pain, for renal pain, for angina pectoris, and for causalgia. They have strengthened their argument throughout by illustrative cases from their own experience. The literature has been extensively reviewed and every important publication of recent years is included.

Two omissions should be pointed out in the hope that they may be corrected in later editions. First, in discussing the technique of the operation for removal of the stellate ganglion by the posterior approach, no credit is given to Henry for his painstaking anatomical studies which made this approach possible. Adson's procedure is but a slight modification of Henry's operation. Second, no mention is made of White's modification of Henry's operation, a modification which transforms it into a pure muscle-splitting and avascular operation, thereby removing the objections mentioned by Gask and Ross. The authors prefer the transabdominal approach for the lumbar sympathetic nerve and an anterior approach according to their own technique for the cervical sympathetic nerve.

All surgeons and physicians interested in the surgery and clinical physiology of the sympathetic nervous system will read this monograph with pleasure and profit.

Physical Treatment by Movement, Manipulation and Massage. By James B. Mennell, M.A., M.D., B.C. (Cantab.). Ed. 3. Philadelphia, P. Blakiston's Son and Co., Inc., 1934. $6.00.

This handbook is an expansion of the scope of previous editions which stressed massage. The author now includes more specifically other methods of physical therapy.

The first chapter is personal in character and is a plea to chartered (registered) practitioners of massage and physiotherapy for a high standard in their work. Ten chapters are devoted to a generalized discussion of the principles of massage, of passive and active movements, and of the relation of these activities to protective rest. The application of the principles of movement, manipulation, and massage to specific pathological condi-

tions comprises the text of the succeeding twenty-five chapters. These pathological conditions include the fields of the general surgeon, the orthopaedic surgeon, the neurologist, the gynecologist, and the internist. A final chapter discusses the use and abuse of the faradic current.

In discussing fractures and dislocations, indeed any condition where muscle spasm plays a leading part, the author emphasizes the value of gentle stroking to produce relaxation of muscles, as opposed to heavy massage. For the treatment of fractures and dislocations, he warns that only experienced masseurs should be employed, pointing out that the responsibility for the maintenance of correct bone-setting rests with the surgeon, who must be assured that his work will not be disturbed by inexperienced masseurs and physiotherapists. The reader feels that the author, in his discussion of fractures and dislocations, knows the subject from the standpoint of the surgeon as well as that of the trained technician.

In the chapter on "Reeducation of Muscles", there is evident a clear understanding of the physiology of muscles and of the mechanism of fatigue. The author states that the first law of treatment is "little and often". Emphasis is placed upon careful progression through passive, assistive, active, and resistive exercises, and upon the importance of practising these principles. Then follow details of muscle training as applied to various joint controls.

There is a very full discussion of low-back pain and some interesting diagnostic tests are presented, some of which the reviewer believes appear for the first time.

In the chapter on "Massage and Splintage", the orthopaedic surgeon will find but little that is new in the mechanical devices described, but the discussion of the relationship between bracing and massage and passive and active movements should be helpful to the surgeon and the physiotherapist alike.

In the final chapter on "Use and Abuse of the Faradic Current", the author rightly states that its use consists in aiding muscle development and muscle reeducation, and that its abuse lies in expecting it to be a cure-all in restoring muscle function.

In America, a greater distinction is made between the masseur and the physiotherapist than is made by this author. All in all, however, this book is a valuable contribution to the subject dealt with.

HANDBUCH DER GESAMTEN UNFALLHEILKUNDE. Herausgegeben von Fritz König und Georg Magnus. III. Band. Stuttgart, Ferdinand Enke, 1933. Lief. 1, 70 marks; Lief. 2, 9.80 marks; Lief. 3, 12.60 marks; Lief. 4, 11.20 marks; Lief. 5, 11.70 marks.

This volume contains 659 pages and 290 illustrations. It is devoted to a discussion of industrial injuries of the extremities. The subjects which receive the most attention are fractures and dislocations, infections of bones, joints, and soft tissues. A sufficient amount of space is given also to consideration of a group of conditions listed as insufficiency diseases, circumscribed bone injury, bone atrophy, chronic osteomyelitis, osteodystrophy, and malignant tumors of bone. In addition, there are chapters on amputations, prostheses, and orthopaedic appliances.

A large part of this volume consists of discussions, of a more or less general nature, of the peculiarities of bones and joints, and the anatomical, physiological, and mechanical aspects of structures and tissues as they occur normally and in various diseases. In this respect, the development of bone changes following fracture and in the process of healing receives the most attention. This portion is followed by descriptions of the numerous forms of injury as they occur in different parts of the extremities. The main feature is, of course, the treatment of the conditions. In this, the authors adhere quite closely to methods developed in Germany; in fact, throughout the whole book there are very few references to any but German writers. An estimate of the degree of disability is given for every type of injury, or class of injuries, according to the location.

The merit of this book lies, to a large extent, in the inclusion of a wide variety of industrial-disease pictures. The material is gathered together and presented to the reader

in a clear, simple manner. The extensive experience of the authors fully qualifies them for the task they have undertaken. This work may well be recommended to the industrial surgeon who has a reading knowledge of German.

THE PRACTICE OF SURGERY. By Russell Howard, C.B.E., M.S. (Lond.), F.R.C.S. (Eng.), and Alan Perry, M.S. (Lond.), F.R.C.S. (Eng.). Ed. 4. Baltimore, William Wood and Co., 1933. $10.00.

The original plan, as established in the first edition of the work, has been followed in the fourth edition. As stated in the beginning, the book is presented as a text-book for students, to give them an introduction to surgery and to prepare them for the final examinations in that branch of medicine. This general outline has been followed throughout.

The chapters fall into three classifications,—pathological, anatomical, and regional. This system affords an easy and quick access to the information desired. The scope of the book is very comprehensive and no attempt is made to enter deeply into the subjects, as would be necessary in a large work of this character. Sufficient space is accorded to the description of pathological conditions to give the necessary information. Differential diagnoses are frequently given and the general treatment directed.

The book is fully illustrated by photographs and drawings, chosen so as to aid materially in the description of the clinical as well as of the pathological conditions. There are also many colored photographs.

For the purpose for which it is intended, the book is a distinctly valuable addition to the literature.

LESSONS ON THE SURGICAL DISEASES OF CHILDHOOD. By William Rankin, M.B., Ch.B. Glasgow, Alex. MacDougall, 1934. 21 shillings.

The work is best described by the author in his Introductory: "This collection of notes, of lectures and demonstrations given to final-year students, in no way pretends to be more than the groundwork or introduction to the subject which one was able to overtake in the short course of less than twenty class meetings."

The simple explanatory notes are well supported by many pictures and diagrams. The book will be found useful for quick reference and will be of value to the physiotherapist, the student, and the general practitioner.

PROF. H. I. TURNER'S INSTITUTE FOR REHABILITATION OF PHYSICALLY DEFECTIVE CHILDREN. Leningrad, 1933.

This small brochure describes an important institution dedicated to the rehabilitation of crippled children and named after Prof. Turner in recognition of the completion of his fortieth year of activity in connection with this establishment.

This institution was founded in 1890, and, after the advent of the new régime, a fresh impetus was given to the development of the enterprise. Admission to the Institute is restricted to children between four and fourteen years of age, suffering from different types of paralysis and deformities; no acute cases are admitted. The institution is fully equipped for education and rehabilitation, as well as for orthopaedic treatment. The crippled are studied as to mental development, vocational possibilities, etc., and, under the guidance of competent teachers, receive a specially adapted course similar to that given in other State trade schools. A special endeavor is made to eradicate the feeling of inferiority so often found in the crippled, and to give to him full opportunity for a new mental and physical self-dependence.

MINNEAPOLIS GENERAL HOSPITAL. ANNUAL REPORT FOR THE YEAR 1932. Parts I, II, and III. Minneapolis, 1933.

An elaborate report in three parts of the administration, equipment, and financial condition of the Minneapolis General Hospital. In these three volumes are contained reports of the Medical and Surgical Services, including the Laboratory and Research De-

partments. This work is most complete, giving a comprehensive view of the entire Hospital, and should be imitated by all institutions having the means to publish such a survey.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Annales de Médecine Physique et de Physio-Biologie (Anvers, Belgium), XXVI, Fasc. 1–3, 1933.

Boletines y Trabajos de la Sociedad de Cirugía de Buenos Aires, XVII, Nos. 30, 31, 1933.

Medico-Surgical Suggestions (Madras, India), II, No. 12, 1933.

Minerva Medica (Turin), II, No. 47, 1933.

Revue de Pathologie et de Physiologie du Travail (Brussels), IX, No. 6, 1933.

La Tribuna Médica (Havana), VII, Nos. 210–213, 1933; VIII, No. 216–217, 1934.

Programm des 52. Fortbildungskursus der Wiener Medizinischen Fakultät (Vienna), 1934.

*Gelenksteifen und Gelenkplastik. Erwin Payr. I. Band. Berlin, Julius Springer, 1934.

BEITRÄGE ZUR KENNTNIS DER TRAUMATISCHEN EPIPHYSENLÖSUNGEN AN DEN LANGEN RÖHRENKNOCHEN DER EXTREMITÄTEN (Traumatic Epiphyseal Separation of the Long Bones of the Extremities). Ernst Bergenfeldt. *Acta Chir. Scandinavica*, LXXIII, Supplementum XXVIII, 1933.

On the basis of 310 cases of traumatic epiphyseal separation, treated between 1919 and 1928, a study is made of the statistics of incidence, etiology, pathological anatomy, symptoms, diagnosis, and especially prognosis. The writer's cases occurred most commonly between the ages of ten and seventeen years. The epiphyseal lesions were divided as follows: lower radial, 137; lower humeral, 70; lower tibial, 44; lower ulnar, 24; lower fibular, 16; upper radial, 8; upper humeral, 5; and miscellaneous, 6.

The monograph includes an historical summary and consideration of the normal anatomy and physiology. Discussion of the various epiphyses is detailed and many illustrative x-rays are included. A supplement contains the summaries of 319 cases, which include nineteen epiphyseal injuries other than fracture, largely the result of the insertion of metal nails. In the latter cases, only two resulted in shortening, and in these there was also gross mechanical injury of the cartilage at the time of the accident. In only three cases was there premature synostosis without shortening.

The study led to many interesting conclusions, some of which are as follows: These injuries do not offer any less favorable prognosis than analogous periarticular fractures during the period of growth. The arrest of growth with persistent shortening was found in fourteen cases and there was no case of increased length. Arrested growth with persistent shortening occurs much more rarely in man than in animals subjected to corresponding experimental investigation. It would seem impossible in the individual case of epiphyseolysis to exclude with certainty a future shortening of the injured bone.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ÉTUDE COMPARÉE SUR LA COXA VARA DITE CONGÉNITALE ET L'OSTÉOCHONDRITE COXALE JUVÉNILE (COXA PLANA) (A Comparative Study of So Called Congenital Coxa Vara and Coxa Plana). H. Camitz. *Acta Chir. Scandinavica*, LXXIII, 521, 1934.

On the basis of a review of the literature and an exhaustive histological study of the necks of the femora in three cases of congenital coxa vara, the writer concludes that there is no basis for terming the clinical entity *congenital* coxa vara. He prefers to call it juvenile. A comparison of his studies with those of Schwartz and others led him to believe that coxa plana, juvenile coxa vara, and adolescent coxa vara are all variations of the same developmental abnormality.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

* To be reviewed in a later issue.

MULTIPLE MYELOMA COMPLICATED BY INTESTINAL OBSTRUCTION DUE TO AMYLOID INFILTRATION OF THE SMALL INTESTINE. O. S. Randall. *Am. J. Cancer*, XIX, 838, Dec. 1933.

The author reports in detail a typical case of multiple myeloma which developed amyloid disease of the intestine with acute obstruction. There is a careful survey of the literature, with the conclusion that, although amyloidosis is rarely reported as a complication of myeloma, the conditions may be associated more frequently than is generally believed.

The complication should be considered in every wasting disease, whether or not suppuration is present. The report is illustrated with roentgenograms and photomicrographs, and a good bibliography is included.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

DIE BEHANDLUNG OFFENER KNOCHENBRÜCHE AN DER WÜRZBURGER KLINIK IN DEN LETZTEN 10 JAHREN (Treatment of Compound Fractures in the Würzburger Clinic During the Past Ten Years). Rudolf Engelmann. *Arch. f. Arthop. u. Unfall-Chir.*, XXXI, 356, 1932.

Although their method of choice is conservative, still in selected cases the Würzburger surgeons do not hesitate to operate. They believe firmly in absolute fixation, best secured by means of plaster-of-Paris. The wounds are treated by the method of Volkmann, consisting of thorough cleansing, débridement, and suture of the wound edges without tension. Of the operative procedures, they favor the insertion of a Lane plate and their statistics show that this has not produced non-union, but, as compared with the non-operative cases, has actually led to more rapid consolidation.—*Leo Mayer, M.D., New York, N. Y.*

ZUR KENNTNIS DER ISOLIERTEN ABRISSFRAKTUR DER UNTEREN SPINA ANTERIOR OSSIS ILEI (Isolated Tear Fracture of the Anterior Inferior Spine of the Ilium). Hans Hanke. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 377, 1932.

The author reports a typical tear fracture due to an injury at football. The patient, a boy of sixteen, lost his balance just as he kicked the ball with his left leg, causing him to fall backward and toward the right side. After eight days of treatment, in a position of slight flexion, all symptoms disappeared.—*Leo Mayer, M.D., New York, N. Y.*

ÜBER DIE OPERATIONSBEHANDLUNG VON PATELLARFRAKTUREN (Operative Treatment of Patellar Fractures). W. Pfister. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 383, 1932.

After a review of the cases treated at the Clinic of Geheimrat Prof. König, the author comes to the conclusion that operative treatment of fractures of the patella should be the method of choice.—*Leo Mayer, M.D., New York, N. Y.*

EIN FALL VON TRAUMATISCHER (SUBCUTANER) EPIPHYSENLÖSUNG AM OBEREN TIBIAENDE (A Case of Traumatic Separation of the Upper Tibial Epiphysis). Erwin Paal. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 399, 1932.

The patient, a boy aged eighteen years, was injured at football. As he was about to kick the ball back of the goal, the goalkeeper threw himself against the anterior surface of the right calf. This caused the patient to fall toward the side. Roentgenograms showed a forward displacement of the upper tibial epiphysis of such a nature that the middle of the epiphysis rested on the anterior edge of the tibia. Reposition was readily accomplished under anaesthesia, and a perfect functional result was secured.—*Leo Mayer, M.D., New York, N. Y.*

Arbeitsfähigkeit und Arthritis Deformans nach Sportunfällen (Disability and Arthritis Deformans as a Result of Sport Injuries). Fritz Strauss. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 403, 1932.

The author makes a study of the length of time of healing in three groups of patients,—students, policemen, and workmen cared for under the compensation law. The results are as follows:—

Site of Injury	*Group A-Students*	*Group B-Policemen*	*Group C-Injured Workmen*
Knee joint.......	6.16 days	12.46 days	19.37 days
Ankle joint......	3.77 days	7.09 days	13.14 days
Shoulder joint....		13.28 days	17.33 days

He comes to the interesting conclusion that invariably the joint injuries of the students healed much more rapidly than those of the police or the injured workmen.—*Leo Mayer, M.D., New York, N. Y.*

Ergebnisse Operativer und Konservativer Behandlung der Mondbeinnekrose (Results of Operative and Conservative Treatment of Necrosis of the Semilunar Bone of the Wrist). Paul Rostock. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 439, 1932.

Operation was done in fifteen cases, in all of which an attempt was made to remove the semilunar bone completely. In four cases the control roentgenograms showed this attempt to have been successful; there was no reformation of bone. In the other eleven cases, however, removal of the semilunar bone was evidently incomplete because a reformation of bone occurred. In all the cases in which operations were performed, some interference with motion persisted. On comparing the results of these cases with those in which no operation was attempted, after a four-year period, the author was able to show that the percentage of disability was approximately three per cent. for the patients who were operated upon and about twenty per cent. for those who were not. Despite this generalization, the author refers to two cases in which no operation was done and which eventually went on to excellent functional results.—*Leo Mayer, M.D., New York, N. Y.*

Neue Gesichtspunkte zum Redressement des Angeborenen Klumpfusses und Daraus Sich Ergebende Schlussfolgerungen Bezüglich der Ätiologie (A New Point of View in the Correction of Congenital Club Feet). Walter Wisbrun. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 451, 1932.

The author emphasizes the necessity of complete correction of the deformity in the Chopart joint and in the subastragaloid joint before attempting to correct any other features of the deformity. He favors the use of plaster-of-Paris, followed by arch supports which help to hold the foot in the corrected position.—*Leo Mayer, M.D., New York, N. Y.*

Gibt es ein Traumatisch Entstandenes Wirbelgleiten? (Is There a Traumatic Slipping of the Vertebra?). Meyer-Burgdorff. *Arch. f. Orthop. u. Unfall-Chir.*, XXXI, 486, 1932.

The author has studied 100 spines at autopsy and has found three with abnormalities of the so called interarticular portion of the spinal arch,—that portion situated between the ascending and descending articular processes. He has also had occasion to study numerous cases of spondylolisthesis. He proves quite conclusively that thus far no one has been able to show that trauma causes actual slipping. He uses the term "spondylolysis" to indicate a gap in the vertebral arch, and "spondylolisthesis" for an actual slipping. He disagrees with Neugebauer in thinking that a spondylolysis may not be congenital in origin but thinks it may be acquired with repeated traumata. He does not, however, state on what he bases this view. His conclusion is that a traumatic spondylo-

listhesis is an unusually rare clinical occurrence and that in practically all cases the so called traumatic spondylolisthesis had been present for a long time before the accident occurred.—*Leo Mayer, M.D., New York, N. Y.*

Two Cases of Ossification in the Internal Semilunar Cartilage. H. Jackson Burrows. *British J. Surg.*, XXI, 404, Jan. 1934.

Two case reports are given of young adults who, both by x-ray and at operation, showed calcification of the internal semilunar cartilage. From the histological studies it is believed that the process of bone formation is: (1) hyperplasia of the fibrocartilage, with deposition of calcium, a multiplication and enlargement of the cells, and an increase of the proportion of matrix to fibers; (2) replacement of areas of cartilage by loose, vascular, connective tissue; (3) formation of true bone in the walls of the cavities so formed.

Inasmuch as trauma caused both conditions, it is believed that the bone in each case was metaplastic. The bone resembled that formed by the usual ossification of hyaline cartilage.—*Ernest W. Daland, M.D., Boston, Massachusetts.*

Spontaneous Dislocation of the Hip in Childhood. P. N. Ray. *British J. Surg.*, XXI, 523, Jan. 1934.

This is a case report of a Bengali child of six, who, six months previously, had had a severe attack of bacillary dysentery. Dysenteric synovitis in many joints occurred during the convalescence, but after six weeks all the joints except the right hip joint quieted down. Clinical and x-ray examinations showed a posterior dislocation with the acetabulum filled with a bony mass.

The dislocation was reduced by the Lorenz method and a plaster cast was applied. The first plaster was removed in eight weeks and the head was found to be in place. Plaster fixation was continued for a total of four months, after which walking calipers were applied. At the end of a year the patient walked without a limp and there was a good range of motion.

It is believed that the spontaneous dislocation was caused by the excessive muscular atrophy about the hip joint, possibly aided by the overdistension of the joint cavity.
Ernest M. Daland, M.D., Boston, Massachusetts.

The "Clover Leaf" Sling in Paralysis of the Serratus Magnus. H. O. Foucar. *British Med. J.*, II, 865, 1933.

The principle of physiological rest in the treatment of paralyzed muscles, followed by graduated exercises, is discussed. Following an outline of the development, anatomy, and action of the serratus magnus muscle and a brief discussion of the factors which may cause isolated paralysis of this muscle, Foucar, on the authority of Sir Colin McKenzie, states that the position of physiological rest for this muscle is attained when the hand is on the opposite shoulder. He has devised and illustrates a three-looped sling for this purpose; one loop goes about the neck, one about the wrist, and one about the good shoulder to act as an anchor. Reports of two cases successfully treated are given.—*R. I. Harris, M.B., Toronto, Canada.*

Human Tuberculosis of Bovine Origin. William G. Savage. *British Med. J.*, II, 905, 1933.

Savage delivered the Mitchell Lecture on the above subject before the Royal College of Physicians of London. This is an excellent and thoughtful review of the whole situation in so far as it concerns Great Britain.

The incidence of the bovine infection is established by a great volume of statistics from many workers. The distribution of the disease by age and by organs is also based upon numerous statistical figures. The portal of entry is almost exclusively alimentary,

although a few cases of bovine pulmonary tuberculosis are almost certainly air-borne (dust infection in dairy workers). The incidence of tuberculosis in cattle in Great Britain is excessively high, averaging forty per cent.

The author discusses at length, and with perspicuity, the measures necessary to prevent bovine tuberculosis in human beings. Chief reliance must be placed on pasteurization of milk, but, at the same time, some plan should be adopted to weed out tuberculous cattle.

This article is sound and deserves the thoughtful consideration of every person interested in tuberculosis.—*R. I. Harris, M.B., Toronto, Canada.*

Treatment of Compound Fractures of the Tibia. A. Simpson-Smith. *British Med. J.*, II, 1019, 1933.

For the treatment of compound fractures of the tibia, Simpson-Smith recommends, in addition to the usual débridement, fixation of the fragments in accurate relationship to one another by means of a special clamp which protrudes from the wound while sterile plaster is being applied. After the plaster is set, the wound is exposed, the clamp removed, and the wound sutured. This report is based upon the records of twenty cases. The instrument and the operation are illustrated.—*R. I. Harris, M.B., Toronto, Canada.*

Spastic Paraplegia (Little's Disease). Treatment by Repeated Cisternal Drainage. Norman W. Clein. *Northwest Med.*, XXXII, 507, 1933.

The author has treated ten babies ranging in age from one to thirty-four months. The amount of fluid obtained varied from 10 cubic centimeters to 70 cubic centimeters, the average being 42.5 cubic centimeters. From two to four times the amount of fluid may be obtained by this method than by spinal puncture. The greatest relief is noted in spastics with a history of birth injury. The indications for repeated drainage are listlessness, poor appetite, loss of weight, and increased spasticity. The drainages are followed by a dry or semi-dry diet with elimination of salt and sugar.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

Arthritis. Its Dietary Treatment. Weslie E. Gatewood and Leila Wall Hunt. *Northwest Med.*, XXXII, 511, 1933.

This is the conclusion of a series of articles dealing with this subject. The classification of Shapiro and Miller is used, and the authors go into considerable detail in the general dietary analysis. They find a lowered metabolism and decreased blood flow in the arthritic patient. They suggest that the diet should be built upon the following plan: (1) availability; (2) elasticity; (3) adaptability to the habits of taste of the patient; (4) energy-value; (5) right kind of proteins; (6) carbohydrates according to the weight of the patient; (7) organic salts; (8) vitamins. They advise a diminished carbohydrate diet, especially if there is a vitamin deficiency, but place major emphasis upon ample protein and vitamin supply.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

Fractures du Tiers Inférieur des Os de l'Avant-Bras Traitées par l'Immobilisation Plâtrée (Fractures of the Lower Third of the Bones of the Forearm Treated by Plaster-of-Paris Immobilization). R. Soeur. *Rev. de Path. et de Physiol. de Travail*, IX, June 1932.

The author describes a modified Böhler treatment of reduction of fractures of the forearm. He advocates local anaesthesia. The reduction is performed without an assistant, countertraction is secured with a strap attached to the wall. To correct the deformity, plain horizontal traction or traction with flexion or extension, according to the displacement of the fragments, is applied. As soon as the deformity is corrected, horizontal traction is maintained while the plaster-of-Paris is applied to the bare skin. Before the plaster hardens, the hand is put in slight dorsiflexion to secure physiological relaxation of the muscles of the forearm. The patient is permitted to use his hand on the day of the application of the plaster. Six cases thus treated, with uniformly good end results, are described.—*Emanuel Kaplan, M.D., New York, N. Y.*

Operative Lengthening of the Femur. Vittorio Putti. *Surg. Gynec. Obstet.*, LVIII, 318, Feb. 15, 1934.

The writer has used piano-wire traction and countertraction in eleven cases for lengthening the femur, both in children and adults. The greatest difficulty is encountered in those cases of some chronicity "in reality amounting to a true muscle-lengthening operation by slow skeletal traction". The only complication has been temporary "toe drop" in one case.

During the traction period, the patient is supine with semiflexion of the hip and knee. The average traction weight is thirty to forty pounds. The time of lengthening is about twenty days, followed by four months in plaster and several months of limited support and physical therapy.

The technique of the method is described by Dr. Carlo Scuderi.—*Richard B. McGovney, M.D., Los Angeles, California.*

The Common Syndrome of Rupture, Dislocation and Elongation of the Long Head of the Biceps Brachii. An Analysis of One Hundred Cases. Edgar Lorrington Gilcreest. *Surg. Gynec. Obstet.*, LVIII, 322, Feb. 15, 1934.

The writer considers that many diagnoses of sprains, neuritis, subdeltoid bursitis, rupture of the supraspinatus muscle, and particularly arthritis, are made when the symptoms and findings are truly those of the common bicipital syndrome. He describes the syndrome as being due to "wear and tear, complete destruction and rupture and dislocation and elongation of the tendon of the long head of the biceps".

The causes are varied,—pathological and physiopathological conditions or degenerative changes, acute and chronic infectious diseases and neoplasms, physiological predispositions, occupation, fatigue, and trauma.

The types of rupture may be classified according to their site as high (intracapsular) or low (at or below bicipital groove); or according to their development as acute, latent, or intermediate.

The symptoms vary with the condition of the tendon, the cause, the site, and the type of rupture. In a frayed tendon, the final rupture may occur without the knowledge of the patient and the only complaint may be weakness and discomfort. Weakness is the constant symptom. Inspection shows some alteration in shape of the shoulder, and in the arm there may be a tumor, or hollow, or ecchymosis and swelling. Palpation may reveal muscle softening, abnormal perceptibility of the tendon, and changes in tension.

The treatment depends upon an exact diagnosis, and incision is made where one expects to find the lesion. Simple rest in acute flexion for two or three weeks is adequate for lesser tears. Massage should not be started until the arm is being gradually brought down.

In operative repair, the writer favors slipping the long head tendon through the short head and then attaching it to the corocoid. If the rupture is in the muscle proper, a large fascial transplant, as well as suturing, should be done. The prognosis is good for function in early repairs, but varies with the chronicity and extent of injury. The medicolegal aspect is noted.

The study is made from an analysis of 100 cases, and the accompanying illustrations are excellent.—*Richard B. McGovney, M.D., Los Angeles, California.*

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The Journal of Bone and Joint Surgery

LEADERSHIP IN ORTHOPAEDIC SURGERY*

BY MELVIN S. HENDERSON, M.D., ROCHESTER, MINNESOTA

Section on Orthopaedic Surgery, The Mayo Clinic

Members of the American Orthopaedic Association, Guests, Ladies and Gentlemen: My first thought in delivering this address is to assure you how honored I am and how deeply I have appreciated the privilege of serving you as President for the past year; for such an honor is, I presume, part of the harvest of my sowing in the years that too swiftly have gone by. This distinction makes me believe that by good luck my sowing was on fertile soil. My earnest hope is that the friendships which it has been my privilege to enjoy with the members of this Association and their families will continue to flourish. Perhaps there will be more leisure in the coming years to enjoy these friendships.

The fact that the specialty of orthopaedic surgery occupies the high position it holds in the minds of members of the medical profession and the laity puts certain responsibilities on us, not only as individuals but as members of this Association. The American Orthopaedic Association was the first orthopaedic society to be formed in the United States and always has been in the vanguard of the medical specialties of this country in their march of progress toward increased service to the public. This society must continue its leadership.

The Victorian philosopher, Herbert Spencer, stated that in the final analysis specialization was merely another word for progress. New facts are constantly being brought forward; no art or science should be stationary. So we, as specialists, must ever be on the alert to acquire knowledge pertaining to our specialty, and to assimilate, digest, and make use of new facts, thus acquiring that elusive something called wisdom. One hears laments that specialization in medicine has advanced too far, and that it is overdone. It is possible to carry specialization so far that it loses much of its effectiveness. Medicine and the allied fundamental sciences are now so wide in scope, however, that it is utterly impossible for a single individual to comprehend and understand them all. In sur-

*Presidential address before the American Orthopaedic Association, Rochester, Minnesota, June 8, 1934.

gery, acquiring of the technique properly to execute the complicated operative procedures in the various fields might be possible if the surgeon were merely an operator and technician, but not if he is to be a surgeon in the best interpretation of that term. He must confine himself to certain restricted fields in order to be a master. In medicine we cannot go backward to the old days and deny our patients the benefits of advances made. Specialism is here to stay and will increase in degree, to be limited only by the amount of knowledge that accumulates and by economic factors.

We can laugh and enjoy the criticisms and jibes leveled at specialists and still benefit by them. The poorly trained specialist who blossoms out after a few months' preparation, and is too often of the predatory type, is a disgrace to the profession and should be eliminated; on the other hand, the results accruing to the public through the services rendered by the well trained, honorable, conscientious specialist are practically all on the credit side of the ledger. It is essential, however, that each specialty in medicine realize its responsibilities and take steps to put its house in order. It must disseminate the knowledge that is accruing in its field, see to it that facilities are provided for the proper training of young men, that they may make use of the knowledge so often gathered at great cost, see that its specialists are more or less regulated in their practice, and acquaint the profession and thus the public through some proper channels with what the specialty has to offer and with the names of persons qualified to carry on the actual practice. This is a large order and, as the science and art of orthopaedic surgery have increased in range and scope, the activities of any one rather small group have been found insufficient to cope with this problem. Leadership has been accorded the American Orthopaedic Association, and the Association has not failed. Although it could not, as a society, do all these things, its members in various groups have organized other societies to aid in keeping the specialty on a sound footing.

The most constant thing in the world is change, and altered conditions in our social life must be met. The present era in medicine, as in other walks of life, is characterized by rather profound socialistic tendencies. We cannot quarrel with those changes which are beneficial, and we must not be so short-sighted and selfish as to combat those which bring benefits and solace to the masses of the people, even though they may interfere to some extent with our own habits and ways of conducting our practice.

Some twenty-odd years ago, when it became apparent that orthopaedic surgery was destined to become a lusty member of the family of medical specialties, the Orthopaedic Section of the American Medical Association was formed. Also, in the East, Mid-West, and West, orthopaedic clubs and societies were formed to facilitate the gathering together of those who were interested, and the presenting of orthopaedic problems for discussion. In the Mid-West was formed the Central States Orthopaedic Club which soon outgrew its club clothes and was forced to organize into the Clinical Orthopaedic Society. The Pacific Coast gave birth

imilar organizations, now neatly worked into a collaborating organiza-
ı that functions admirably to advance orthopaedic surgery in that
tion. The last year has seen the launching of the American Academy
Orthopaedic Surgeons that promises to link these various district
ups into one component society, the better to enable us to advance
things worth while. The various district societies and clubs, however,
intain their individuality, and the larger organization enhances their
ıl influence and usefulness. This year has witnessed the organization
l incorporation of the American Board of Orthopaedic Surgery, the
ef object of which is to issue certificates to those considered qualified to
ıctise orthopaedic surgery, in order that the profession at large, and
ough them, the public, may know which of those men who set them-
ves up as orthopaedic surgeons are qualified by education, training,
lity, practice, and character to carry on in that rôle. We are taking
: place alongside the other specialties in this commendable undertaking.
e American Medical Association approves this, and under the wing of
ıt great organization much good will be accomplished by this movement.

The American Orthopaedic Association, not by official action, but
ough its members, and always with the tacit consent of its Executive
mmittee, has fostered these various movements. Orthopaedic surgery
he star of hope to those in that great kingdom of crippledom. No one
ows as well as we the sorrow, grief, and yearning that grips the heart of
cripple. Our aim is to lessen that suffering by restoring function,
aightening and strengthening weak, crooked limbs and backs, and thus
lirectly instilling hope and happiness into hearts that knew them not
fore. The longer one labors in this sphere, the stronger grow one's
npathies for these unfortunate cripples, and the more roundly does one
prove and foster efforts of the laity to provide facilities for the carrying
t of projects that will offer aid to them. It is comparatively easy to
lock purses for the care of the crippled child, for the dependent, helpless
ung have an appeal that melts even the hardest hearts; but to secure
oper facilities for the care of that vast and ever-growing army of crippled
ults, recruited from among those who suffer injuries consequent to
lustrial activities and modern, speedy transportation, is more difficult.
ore help is needed for these unfortunates, and our various activities in
is field must be fostered and quickened.

The foresight of the founders of this Association in publishing the
pers presented at its meetings has had more influence on the sound
velopment of orthopaedic surgery in the English-speaking world than
ıy other one thing that has been done. The Association first published
e papers and discussions in the Transactions. Later, it took the respon-
oility of owning and publishing the *American Journal of Orthopaedic
ırgery* which attained a considerable circulation. In 1922 the title was
ıanged to *The Journal of Bone and Joint Surgery*. Under the guidance of
ır Editor, Dr. E. G. Brackett, the publication has become increasingly
ıcful and popular. It is the only magazine of its kind published in the

English language; it is owned by the American Orthopaedic Association, the finances being supervised by our Treasurer, Dr. John L. Porter. It is due to the efforts of these two men that *The Journal* is so successful. The British Orthopaedic Association has adopted it as the official organ of the Association, and this has been a great help.

The American Orthopaedic Association, as the parent, so to speak, of the various organizations that have to do with the problems of orthopaedic surgery, must look to the future; but it may, I believe, do much to advance our cause by looking into the past. The character of its membership makes this possible. Membership in this Association is accorded men who have advanced and become leaders in the field. They not only have at their command wisdom, gained by years of exacting labor and effort, but they possess a vast amount of material comprising records of many cases. It is astonishing how lacking we are in knowledge of end results! Who are more fitted than the men in this organization to sum up the results of treatment and properly to evaluate it? We must, therefore, as we are doing at this meeting, discuss methods of treatment and be prepared to pass judgment on their value. Younger men in the other societies will bring up for discussion methods of treatment which may seem old to us, but which present themselves as fresh problems to them. These men will discuss the adaptability of certain procedures, and the technique of their execution; but it will be for members of this society to discuss these problems in the light of greater experience.

We must support the other societies, for they afford us an opportunity of meeting and exchanging ideas and experiences with the younger men, the group from which our membership will be recruited and from which will come those who will take up our work as we drop it.

In conclusion let me reiterate that specialization is essential for progress. Specialization will increase, controlled by two forces,—namely, the fund of new information that is acquired, and economic factors. The price paid by the public for specialization in medicine is not too great; the great benefits outweigh the debits. We must watch to see that those who are taken in as members of this society are well educated, that they are well trained, and that they are men of character, of intellectual honesty, and of integrity. They are future leaders in orthopaedic surgery.

A NEW RADICAL OPERATION FOR POTT'S DISEASE

Report of Ten Cases*

BY HIROMU ITO, M.D.
Professor of Orthopaedic Surgery,

AND JUNICHI TSUCHIYA, M.D.
Assistant Professor of Orthopaedic Surgery, Kyoto Imperial University, Kyoto, Japan

AND GOICHI ASAMI, M.D.
Surgeon-in-Chief, Okinoyama Dojin Hospital, Ube, Japan

The principles underlying the treatment of tuberculous spondylitis, which have been universally adopted today, consist of giving rest to and alleviating weight thrown upon the diseased vertebrae by application of an immobilizing bandage, and of promoting the natural processes of healing by general hygienic measures. The operative measures of Calot, Henle, Hibbs, and Albee are essentially immobilizing procedures and are directed to the same purpose,—namely, rest and relief of weight upon diseased vertebrae. Consequently, the purpose of the surgical treatments so far devised does not differ fundamentally from the object of the non-surgical conservative measures.

Through the recent advancement of surgery, it has become possible to remove lesions lying not only within the abdomen, but in practically all the body cavities, including the chest, spine, and cranium. An outstanding example of one of the few exceptions has been the fact that no radical measure for Pott's disease has yet been devised. The reasons for this fact, we believe, may be summarized as follows:

1. The symptoms of the disease are relatively mild, and the patients frequently prefer non-operative treatment.
2. An early diagnosis is often difficult and indication for an operation not easily recognized.
3. A fairly satisfactory result usually follows conservative measures.
4. Since the vertebrae are deeply situated, surgical approach and technical procedures upon them are fairly difficult.
5. Because of the important rôle they play in bearing the body weight, a radical operation upon them must necessarily be followed by instituting a proper substitute for weight-bearing.
6. Tuberculous lesions are especially susceptible to a secondary infection.
7. Even if a secondary infection does not occur, it is often difficult to obtain a primary healing of any surgical wound upon a tuberculous lesion.

* Received for publication July 20, 1933.

8. The patients who desire a radical operation more often than not present quite severe cases and the postoperative prognosis of such cases, naturally, is frequently unsatisfactory.
9. Even if an early case presents itself for an operation, it is difficult to locate a small localized lesion at operation.
10. Dangers incident to the operation itself are not to be regarded lightly.

The literature on radical operation for Pott's disease shows a series of unsuccessful attempts made by various writers. Tillmanns, Hoeftman, Sick, and Krause each attempted to remove a lesion by laminectomy. An effort was made by each of these surgeons to reach the body of the vertebra by retracting the spinal cord to one side, and to resect the diseased part of the body. However, it was found necessary to section many nerve roots in order to retract the cord sufficiently for the purpose, and, on account of the narrowness of the field of operation, it was impossible to remove the diseased part completely. The practice of leaving the wound open with tampon of iodoform gauze further helped to render the prognosis gloomy, and the mortality was considerable.

Another series of attempts at radical operation was made by Vincent, Parona, Willard, Tillmanns, Schöffer, Treves, and Ménard, each of whom performed a costotransversectomy through a paravertebral incision, approaching a lesion in the body of the dorsal vertebra. Since the primary object of the operation by these surgeons was evacuation of pus, drainage was instituted; and, as a consequence, the majority of the patients succumbed to a secondary infection; in many of the others permanent fistulae resulted; and a complete cure was rare and accidental.

Müller, in a case of suspected sarcoma of the ventral aspect of the sacral promontory, discovered at operation through a median suprapubic incision a cold abscess resulting from caries of the lumbar vertebra. After thoroughly curetting the diseased bone surface with iodoform powder, he sutured the wound. The result from this was excellent, but subsequent attempts at the same procedure in other cases resulted so disastrously that he was forced to discontinue its further use.

Podres approached an abscess in a child of eleven, with paralysis of the upper extremities and difficulties of deglutition and respiration, by an incision along the external border of the sternocleidomastoid muscle, with an excellent result.

Burkhardt performed a similar operation by an incision along the anterior border of the sternomastoid muscle and Payr reached a lesion in the atlas by an oblique incision from the tip of the mastoid process to the mid-line, but these operations have not been repeated by other surgeons.

These attempts at radical operation had been made prior to 1910, in the period of antiseptic surgery. In the recent European and American literature, we fail to find a reference to any new attempt at radical treatment of Pott's disease. The surgery of tuberculous spondylitis has been confined to the methods of immobilization, of which Albee's technique is

the one most widely practised. Thus, up to the year 1932, a radical operation for Pott's disease was not only regarded as an impossibility but anyone who attempted such an operation was branded as a reckless surgeon.

The so called aseptic surgery of today, however, has practically revolutionized many of the operative procedures of the antiseptic age that existed up to 1910. By the present aseptic method a primary healing of the operative wound is the rule and the costal and pericostal tuberculosis are considered to be most amenable to surgical cure. In this period of surgical enlightenment, the question of why a result similar to that in the treatment of costal tuberculosis cannot be obtained by a radical operation for tuberculosis of the vertebra is not easy to answer.

It is doubtless true that in many cases of Pott's disease, the current conservative measures yield results satisfactory to both the surgeon and the patient, but, since the prolonged period of treatment necessary causes considerable inconvenience and economic loss to the patient, the need of a more rational and speedy cure has been recognized, and efforts toward attaining this goal have constantly been made by us.

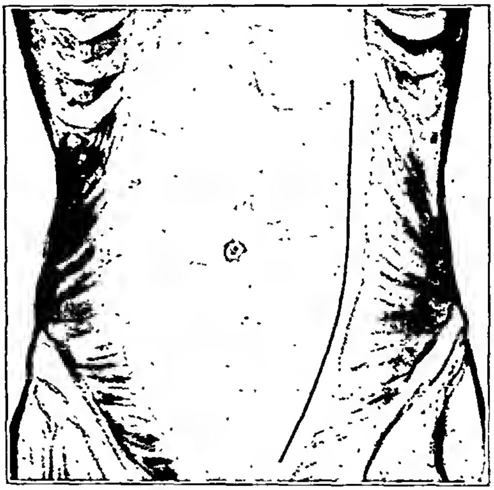

FIG. 1

Pararectal incision usually employed in the present series.

In 1923, we originated a technique of lumbosacral sympathetic ganglionectomy for the purpose of improving the circulatory conditions of the lower extremities, the results of which were reported to the Japanese Surgical Society in 1925. Subsequently, the technique was modified so that now the incision is made on the flank, and the sympathetic chain removed extraperitoneally. During repeated operations by the new technique, it occurred to us that by this approach the vertebral column could be reached with remarkable ease. We felt that a total resection of the body of a vertebra should not be difficult, and a plan for application of this idea to radical treatment of caries of the vertebra has been slowly developed.

THE TECHNIQUE OF OPERATION

A. For Pott's disease of the lumbar vertebrae either general or spinal anaesthesia is employed. A left pararectal incision is usually made in order to avoid injuries to the aorta and the inferior vena cava (Fig. 1). In a case presenting a gravitating abscess on the left side only, the right

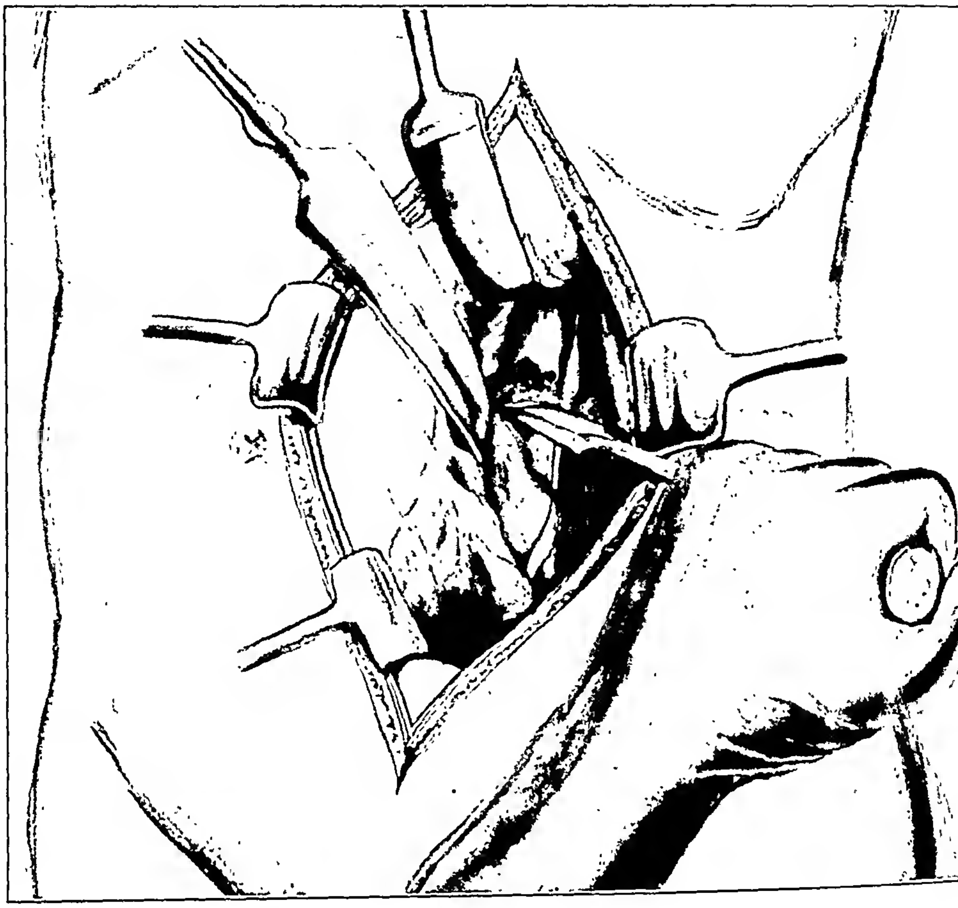

FIG. 2

Extraperitoneal exposure of the body of the lumbar vertebra and resection of the body with a chisel.

pararectal incision is chosen. The peritoneal fold containing the abdominal viscera is retracted toward the mid-line, and by a little further blunt dissection the retroperitoneal space is reached. At this stage of the operation it does not require much more dissection to expose the bodies of the lumbar vertebrae. The anterior longitudinal ligament of the diseased vertebrae is divided in the direction of its fibers, and the granulation tissue and the sequestrum are scraped out with a sharp curet. Then as much of the solid bony tissue forming the wall of the lesion as is deemed necessary is removed by means of a chisel (Fig. 2). The anterior longitudinal ligament is now sutured and the abdomen closed.

If there is an abscess at the site of the proposed operation, it is aspirated previous to the incision. Should more pus be found remaining in the iliopsoas muscle during the operation, the aspiration is repeated under direct vision, and the abscess cavity is opened close to the diseased body of the vertebra. Then the anterior longitudinal ligament of the affected vertebra is incised; the diseased portion of the body is thoroughly curetted out; and the bony tissue forming the wall of the lesion is chiselled off; and, after suturing the divided anterior longitudinal ligament, the cavity of the psoas abscess is closed air-tight close to the curetted body of the verte-

bra, in order to shut off any direct communication between the vertebra and the abscess cavity. The abdomen is now closed. By this technique it is possible to reach the sacrum, and all of the lumbar vertebrae, with the exception of the first lumbar for which a special technique has been devised.

B. For Pott's disease of the first lumbar and the twelfth dorsal vertebrae, a skin incision is made parallel to, and from two to three centimeters away from, the spinous processes of the corresponding vertebrae. The fascia lumbodorsalis is split longitudinally; the sacrospinal muscle is retracted laterally; the transverse process of the first lumbar vertebra, or, in the case of involvement of the twelfth dorsal vertebra, the last rib is resected; and the lesion is reached readily by dissecting deeply. As this technique produced considerable bleeding, however, it was modified as described below.

An oblique skin incision is made, beginning at the level of, and from two to three centimeters away from, the spinous process of the eleventh or twelfth dorsal vertebra, and curving toward the anterior superior spine of the ilium, as in Bergmann's incision for nephrectomy. The oblique and transverse abdominal muscles are incised; the sacrospinal muscle is retracted medially; and the retroperitoneal space is reached extraperitoneally. In this way, resection of the transverse process is made unnecessary and hemorrhage is reduced to the minimum; but the fact that the body of the vertebra is at a considerable distance from the skin incision is an inconvenience. It is difficult to decide which one of these methods is superior, and a new and better approach may possibly be devised in the future. It may be stated definitely, however, that a surgical approach to the bodies of the twelfth dorsal and first lumbar vertebrae is not a very difficult matter.

C. For Pott's disease in the dorsal vertebrae a different incision is necessary. An approach to the bodies of the vertebrae in this region is made by a costotransversectomy in which both the transverse processes of the vertebrae and the corresponding ribs are resected. We have made it our working principle to resect three ribs in order to make an approach to one vertebral body. In this way the field of operation is made ample, and the operative manoeuvers easy of performance. It must be kept in mind, however, that, whereas in those cases in which the ribs are also diseased—as in costal tuberculosis—the pleura is definitely thickened and danger of perforation is slight, in those with healthy ribs there is no hypertrophy of the pleura to insure its safety; therefore, in resecting the normal ribs, care must be exercised against injury to the pleura.

The next consideration is the method of repair of the resected part of the vertebra. We have tried two methods. In a certain number of cases we have tried Albee's technique of immobilization, the transplantation being performed three weeks or more after the radical operation. This technique was found to be safe and perfectly effective in relieving the defective vertebral bodies of their weight-bearing function, but the necessity of dividing the operation into two stages is a definite drawback.

For this reason, we have tried another method in which either a tibial graft or a portion of a rib is implanted into a groove made in the bodies instead of into the spinous processes of the vertebrae. In this procedure the diseased body of the vertebra is first resected; the intervertebral cartilages on both the upper and lower surfaces of the body are either scraped off or trimmed away with a pair of scissors. Then, in the middle of the body of the healthy vertebra below the one resected, a hole about one centimeter deep is bored with a drill perpendicularly to the surface of the disc; and on the side of the body of the healthy vertebra lying above the resected one, a longitudinal groove of the size that corresponds to that of the proposed transplant is made (Fig. 4). A bone graft with one end tapering into a sharp point is obtained from the tibia; the point is forced into the hole previously prepared in the body of the lower vertebra, and the other end of the graft is firmly secured in place by means of a specially made chisel.

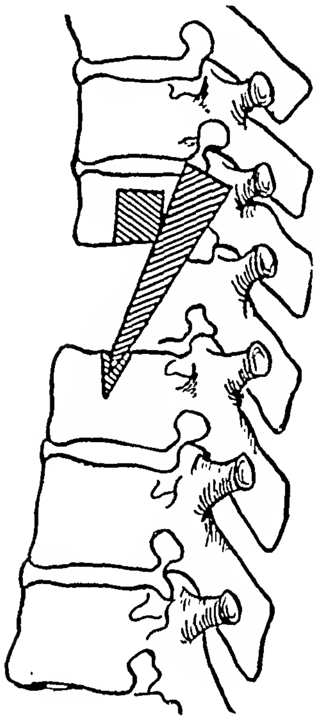

FIG. 3

Schematic drawing to show the direct method of bone transplantation.

Quite naturally one would doubt the efficacy of such a slender graft in compensating for loss of the vertebral body in weight-bearing. In order to determine this point, we removed a body of a lumbar vertebra in the rabbit by the transabdominal route, and transplanted a fibular graft into a groove made in the body of the vertebra above and below the resected one. Three months after the operation, it was found that the bony union at the site of the transplant was firm, that there was a surprisingly large quantity of callus formed between the healthy vertebrae and the graft, and that there was no mobility in any direction in the region of the transplantation; this region of the vertebral column was found to be able to withstand a weight of twenty kilograms. From this experimental finding we have felt that a similar result may be expected in man. It is our expectation to stimulate callus formation by thoroughly chiselling off the eburnated bony tissue of the body of the vertebra previous to transplantation.

REPORT OF CASES

CASE 1. T. U., a farmer's wife, twenty-nine years old, was admitted to the Clinic, April 30, 1932.

Chief Complaint: Dull pain in the lumbar region.

Present Illness: About two years before she had first noticed a dull pain on bending the back, which had gradually increased in intensity till it had become difficult to walk.

Examination showed a young woman of medium build with fairly good nutrition. Both apices and the right anterior chest were slightly dull to percussion and breath sounds were weak; posteriorly, in addition to dullness on percussion, there were sonorous râles.

Locally, the dorsal spine was curved to the right, and there was a marked kyphosis at the first lumbar level with rigidity, but there was no tenderness to palpation or percussion.

Diagnosis: Spondylitis of the first and second lumbar vertebrae.

Radical Operation, May 4, 1932: Under general anaesthesia a curved incision sixteen centimeters long was made, beginning about two fingers' breadth to the left of the spinous process of the tenth dorsal vertebra, curving toward the right and ending at one finger's breadth posterior to and above the posterior superior spine of the left ilium. The fascia and the muscles of the back were incised and retracted, and about five centimeters of the twelfth rib next to the costovertebral articulation, as well as the transverse processes of the first, second, and third lumbar vertebrae, were resected (Fig. 4).

Fig. 4

Case 1. Mrs. T. U. Appearance of the operative wounds shortly before discharge.

Approach to the bodies of these vertebrae was at first attempted close to the mid-line; but, owing to profuse hemorrhage, this attempt was abandoned and we reached the left lateral aspect of the twelfth dorsal, first, second, and third lumbar vertebral bodies by a slightly lateral approach. Tuberculous granulation tissue was found mainly between the first and second lumbar vertebrae; and, as this was scraped out, a trace of pus was noted coming both from the lower part of the first and the upper part of the second lumbar vertebrae. Resection of these evidently diseased portions of the bodies was done, and the surrounding atrophic bony tissue was chiselled away. The anterior surface of the body of the twelfth dorsal vertebra was also curetted. The muscles, muscle sheaths, and skin were then sutured in layers, the patient placed in prone position, and a plaster-of-Paris bed prepared. Immediately after the operation the pulse was rapid and weak; a transfusion of 300 cubic centimeters of blood was given and the patient was returned to bed.

Postoperative course was uneventful and the wound healed by primary intention.

Twenty-seven days afterward, immobilization by the Albee operation was performed, and the patient was discharged with a plaster jacket sixty-one days after the radical operation.

At present the general condition of the patient is excellent, and there is neither any pain nor are there signs of abscess in the region operated upon.

Case 2. C. M., a married woman, thirty-seven years old, was admitted to the Clinic, May 25, 1932.

Chief Complaint: Pain in the lumbar region and difficulty of locomotion.

Present Illness: In January, 1931, lateral curvature of the spine was first noted. Soon after childbirth, on September 3 of the same year, she had been confined to bed with pain in the lumbar spine and inability to walk, although the pain had somewhat abated at the time of admission.

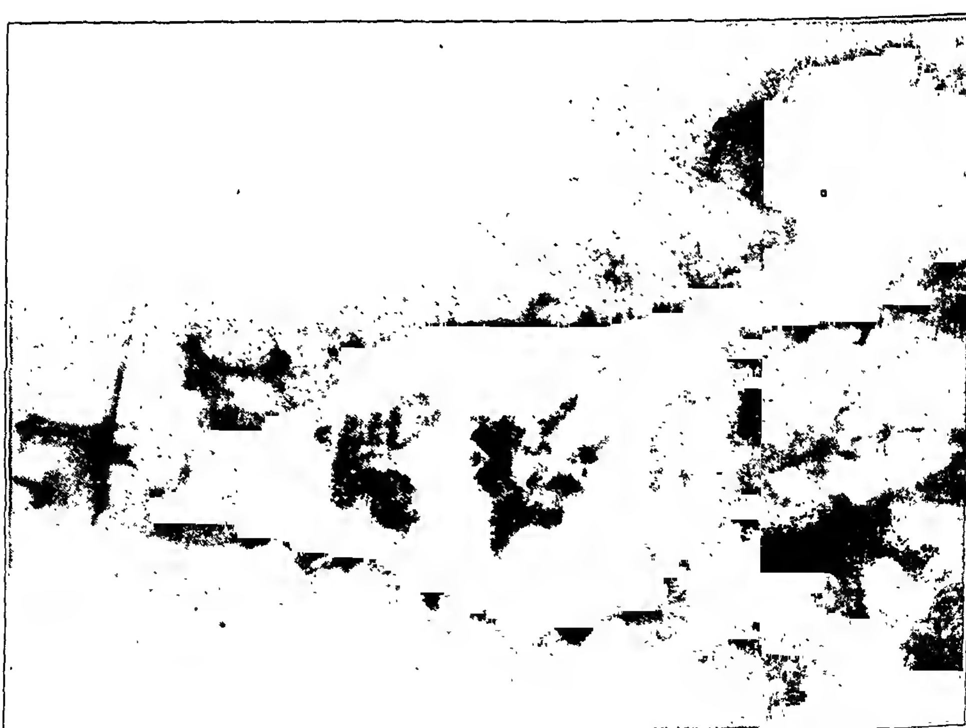

FIG. 5-A

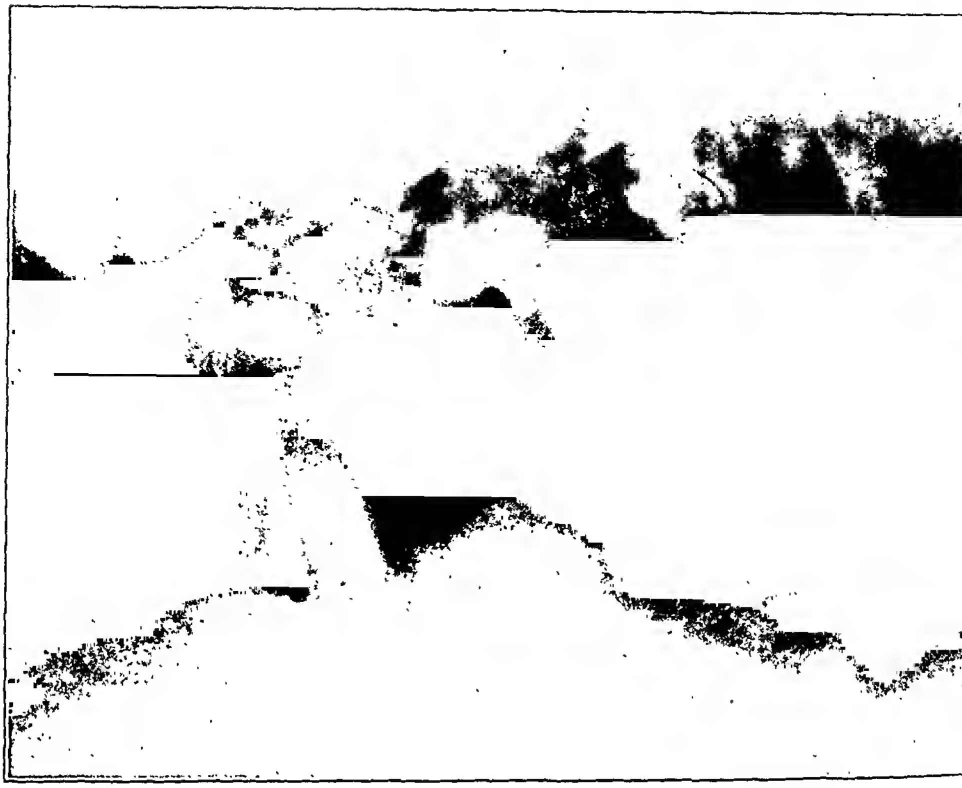

FIG. 5-B

Case 4. Mrs. C. K. Preoperative roentgenograms showing the vertebral lesion.

Fig. 6–A

Fig. 6–B

Case 4. Mrs. C. K. Roentgenograms showing the condition of the transplant and the vertebræ sixty days after the one-stage operation.

Examination showed a fairly well nourished woman of middle age. Locally, the lumbar spine was curved to the left, and there was definite rigidity. In the left iliac fossa was palpable an abscess the size of the fist; in the right iliac fossa, also, a slight resistance and fluctuation were noted. The knee and Achilles' tendon jerks were exaggerated bilaterally.

Diagnosis: Spondylitis of the fourth dorsal vertebra with bilateral psoas abscesses.

Radical Operation, May 27, 1932: An incision approximately fifteen centimeters long was made, the center of which passed through a point three fingers' breadth above the left iliac crest, its direction being from above behind anteriorly and inferiorly. The incision was deepened layer by layer until the peritoneum was reached. The peritoneum was then separated from the extraperitoneal tissue by blunt dissection, and the retroperitoneal space was reached. The abscess was aspirated and then opened, and the left anterolateral surface of the body of the fourth lumbar vertebra was exposed. The diseased part was recognized by the roughness of its surface and the brittleness of the tissues. This part was thoroughly curetted out and the bony tissue in the immediate vicinity was cut away with a chisel. The incision that was made in the wall of the abscess was sutured, and the continuity between the abscess cavity and the resected portion of the vertebra was obliterated completely by ligature. The muscles, fascia, and skin were then sutured in layers. Immediately after the operation the patient was placed in a prone position and a plaster-of-Paris bed was made. The patient was returned to bed and ordered to keep the dorsal posture.

Two weeks after the operation, a fistula developed at a part of the operative scar; this gradually closed, however, in the course of two months, when an operation after the method of Albee was performed. A month after this, the patient was discharged with all the wounds nicely healed. The plaster jacket was removed three months after discharge. The original symptoms have cleared up and the patient experiences no difficulty in walking.

In the following cases, only the essential features of each case are given.

CASE 3. K. I., a girl of eighteen years, a dressmaker, was admitted to the Clinic on June 6, 1932. Present illness began in July 1931.

Diagnosis: Spondylitis of the fourth and fifth lumbar vertebrae, with a slight kyphosis of the lumbar spine, a mild degree of lumbar lateral curvature, and an abscess in the right iliac fossa.

Patient appeared moderately well nourished.

Operation, June 10, 1932: The vertebrae were exposed through a right pararectal incision. The lower portion of the fourth lumbar vertebra was found to be sequestrated. With curettage of the necrotic tissue, the upper portion of the fifth lumbar vertebra was also found to be sequestrated and the intervertebral ligament replaced by granulation tissue. After curettage and chiselling off of the eburnated tissue, a defect, three centimeters wide and eight inches long, was exposed. The abscess wall was sutured air-tight and the wound closed in layers.

Second Operation: Three months afterward, immobilization by tibial graft, after the method of Albee, was performed. The patient was discharged 129 days after the first operation.

Result: Six months after discharge, there was no pain nor difficulty of locomotion and no sign of abscess formation. Hypaesthesia of the lower extremities had also disappeared.

CASE 4. C. K., a married woman, forty-eight years of age, was admitted on June 11, 1932. Present illness dated from July 1931.

Diagnosis: Spondylitis of the fourth and fifth lumbar vertebrae, with kyphosis of lumbar spine and bilateral psoas abscesses.

At the age of twenty-seven she had had an operation for caries of the rib. Patient was rather frail and emaciated. Reflexes were hyperactive.

Operation, May 15, 1932: Just before operation, 120 cubic centimeters of pus was evacuated from the right iliac fossa. The peritoneum was reached through a left pararectal incision. A focus of tuberculous pus and a sequestrum were found in the lower portion of the anterior surface of the fourth lumbar vertebra. A part of the body of the fifth lumbar vertebra was also found to be sequestrated and brittle. After curettage of the diseased area and chiselling off of the eburnated tissue, a defect of the vertebrae, the size of a pigeon's egg, was exposed. A wedge-shaped tibial graft was prepared and inserted in the healthy central portion of the fifth lumbar vertebra and in a longitudinal groove made on the fourth lumbar vertebra. The anterior longitudinal ligament was sutured and the wound was closed in layers. The patient was placed in a plaster-of-Paris bed.

The wound healed by first intention and the postoperative course was uneventful. There was no reaccumulation of pus. The patient was discharged on the sixty-third day after operation. The nutrition of the patient was excellent, the reflexes normal, and the gait normal.

Result: In February 1933, the general condition of the patient was satisfactory,—no pain, no abscess reformation, reflexes normal.

Case 5. Y. I., a watchmaker, twenty-nine years of age, was admitted on June 4, 1932. Symptoms of present complaint began seven years previously. A year later, kyphosis in the mid-dorsal spine developed, for which support was given. There had been a gradual increase of the kyphosis.

Diagnosis: Spondylitis of the tenth dorsal vertebra, with kyphosis.

The patient was of medium build and fairly well nourished.

Operation, June 17, 1932: Approach was made by a left paravertebral incision, twenty centimeters in length, with mid-point at the tenth dorsal vertebra. Segments, three centimeters in length, of the ninth, tenth, and eleventh ribs were resected close to the costovertebral articulations. The transverse processes were also resected. The pleura was separated by blunt dissection. The body of the tenth dorsal vertebra was found to be flattened and there were traces of granulation tissue and a small sequestrum. These were curetted out and the atrophic bone chiselled off. A piece of one of the resected ribs was inserted into the defect of the vertebra. The anterior longitudinal ligament and overlying parts were sutured in layers. The patient was placed in a plaster-of-Paris bed.

The convalescence was uneventful; the wound healed by primary intention, and the patient was discharged forty-five days after the operation. The general condition of the patient was excellent,—no tenderness, pain, nor sign of abscess reformation. Gait was normal and not followed by fatigue or pain.

Result: Eighty-eight days after the operation, the patient's condition was excellent and there was no complaint.

Case 6. T. F., a farmer, twenty-three years of age, was admitted on August 29, 1932. Present illness dated from November 1931. At the age of eighteen, he had had tuberculous arthritis of the right elbow and, at twenty-one, a dry pleurisy.

Diagnosis: Spondylitis of the second lumbar vertebra, with slight kyphosis.

The patient was of medium build with slightly impaired nutrition.

Operation, August 31, 1932: Under local anaesthesia, approach was made by a paravertebral incision, fifteen centimeters in length, with mid-point at the second lumbar vertebra. The dissection was kept close to the body of the vertebra to avoid the spinal nerves and vessels that emerge from the intervertebral ligament at that area. Necrosis of the right lower portion of the body of the vertebra was discovered. There was no pus. The diseased area was thoroughly curetted and the eburnated tissue in the vicinity was chiselled off, leaving a defect the size of a pigeon's egg. A tibial graft, five centimeters in length and one centimeter in width, was inserted into the bodies of the vertebrae above and below. The anterior longitudinal ligament and overlying tissues were sutured in layers. The patient was placed in a plaster-of-Paris bed.

The convalescence was uneventful and the wound healed by first intention.

Fig. 7–A

Fig. 7–B

Case 8. Miss Y. Y. Preoperative roentgenograms showing the vertebral lesion and downward tilting of the affected body.

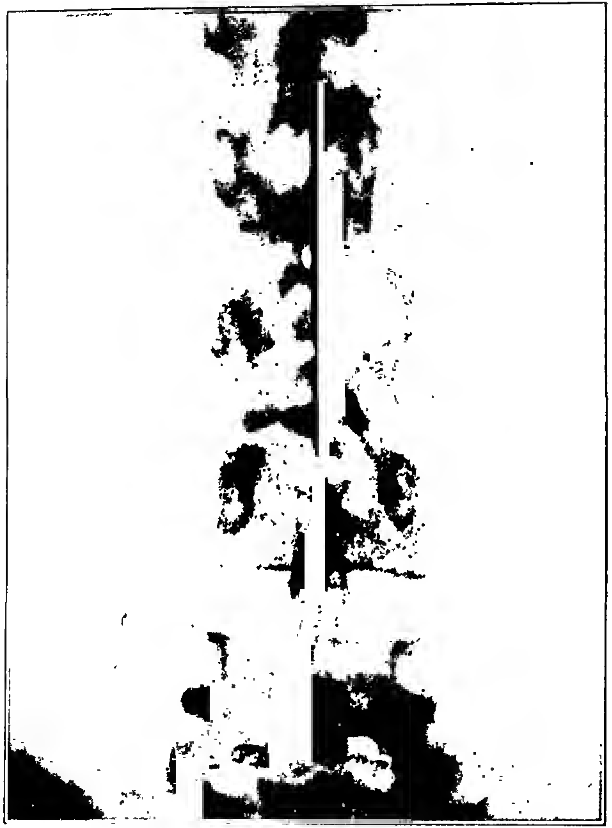

FIG. 8-A

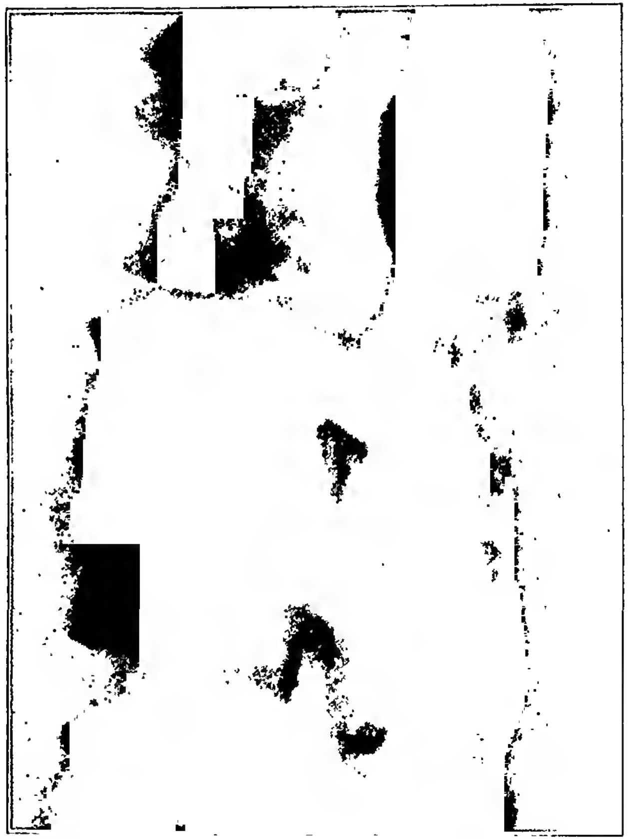

FIG. 8-B

Case 8. Miss Y. Y. Roentgenograms showing the condition of the transplant and vertebrae one month after operation by the Albee method. The lateral view shows how the preoperative downward tilting of the diseased body of the vertebra has been corrected.

Result: The patient was discharged two and a half months after the operation, completely relieved of symptoms.

CASE 7. T. T., a seamstress, aged thirty-four years, was admitted on November 14, 1932. Symptoms of present illness dated back two years. Pain and weakness of the leg were prominent symptoms and at one time the patient had been unable to walk at all.

Diagnosis: Spondylitis of the fourth and fifth lumbar vertebrae, with kyphosis; lateral curvature to the left in the mid-dorsal region; an abscess, the size of a fist, easily palpable in the right iliac fossa; and a smaller mass in the left iliac fossa; signs of pulmonary involvement.

Operation, November 16, 1932: Before operation, 500 cubic centimeters of pus was evacuated by aspiration from the abscesses in the iliac fossae. Approach was made by a left pararectal incision from the level of the umbilicus to the symphysis pubis. The abscess was incised close to the body of the fourth and fifth lumbar vertebrae, the diseased portions of which were curetted, and two fair-sized sequestra were removed. After the intervertebral ligament of the fourth lumbar vertebra was dissected off, pulsation of the aorta was found directly in front of its body. The abscess on the left side was found to communicate with that of the opposite side at this point. The upper portion of this abscess was closed by a purse-string suture, cutting off continuity between it and the resected portion of the vertebrae. The anterior longitudinal ligament and other structures were sutured in layers.

Six days after the operation, stitch abscesses developed, with thick, creamy pus, but the deeper layers were not involved. One month after the operation, there developed pain, redness, and swelling in the right lower abdominal quadrant. Two weeks later, a sinus formed with purulent discharge, which gradually lessened and at the time of this report suggested spontaneous closure in the near future.

Result: At the last report, the general condition of the patient was good,—the lumbar pain and hypaesthesia had disappeared.

CASE 8. Y. Y., a girl, nineteen years of age, was admitted on December 12, 1932.

Diagnosis: Spondylitis of the third lumbar vertebra, with kyphosis and right psoas abscess.

The patient was fairly well nourished, with a suggestion of involvement of the right lower chest. Both knee jerks were exaggerated.

Operation, December 14, 1932: Previous to the operation, the abscess in the right iliac fossa was aspirated. Approach was through a left pararectal incision. With the incision of the anterior longitudinal ligament and the separation of the periosteum, considerable granulation tissue was discovered, which was curetted. Three fragments of sequestra were removed and the bony wall of the lesion was chiselled off. The defect in the bone was filled with a portion of the psoas muscle with pedicle, over which the periosteum of the vertebra and the ligament was sutured. The abdominal wall was closed and sutured in layers and the patient was placed in a plaster-of-Paris bed.

Convalescence was uneventful and the wound healed by first intention.

Second Operation: Twenty-nine days after operation, immobilization by tibial graft, after the method of Albee, was performed. One month later, the patient was discharged.

Result: There was no difficulty in walking and no abscess reformation.

CASE 9. N. Y., railway worker, aged twenty-nine years, was admitted to the Clinic on January 19, 1933. Illness began a year and a half before admission.

Diagnosis: Spondylitis of the second and third lumbar vertebrae, with kyphosis.

Patient was of medium build, with somewhat impaired nutrition. There were suspicious signs in the chest over the right lower posterior lobe. At the age of seventeen, the patient had had pleurisy. Reflexes were exaggerated bilaterally.

Operation, January 20, 1933: Approach was through a left pararectal incision, eight inches in length, at a point two centimeters below the costal arch. In dissecting off the peritoneal fold, a portion was torn, which was immediately sutured. At the origin of the psoas muscle was found a dark-red oblong swelling on the left aspect of the body of the

fourth lumbar vertebra. This was punctured and five cubic centimeters of thick, brownish-gray pus was obtained. The abscess wall was then incised and through the incision the bodies of the second and third lumbar vertebrae were curetted, and several small sequestra were removed. After thorough curettage and chiselling off of the adjacent bony wall, the abscess wall was closed air-tight with purse-string sutures, obliterating its continuity with the vertebral focus. The wound was closed in layers and the patient was placed in a plaster-of-Paris bed.

The wound healed by first intention.

Second Operation: One month later, immobilization by tibial graft, after the method of Albee, was performed.

Convalescence was uneventful and, at the time of making this report, the patient was ready to be discharged.

CASE 10. Y. K., a farmer's wife, aged thirty years, was admitted to the Clinic on January 23, 1933. Present illness began after childbirth, three years previously, with complaint of pain, accompanied by spastic paralysis of the lower legs and feet, with hypaesthesia of both thighs. This improved after seven months.

Diagnosis: Spondylitis of the twelfth dorsal and first lumbar vertebrae, with kyphosis.

Patient was of moderate build with somewhat impaired nutrition.

Operation, January 25, 1933: Approach was through an oblique incision, seventeen centimeters in length, from the level of the tenth dorsal vertebra and three fingers' breadths to the left, extending downward and anteriorly. Segments of the eleventh and twelfth ribs, three centimeters and five centimeters long respectively, together with a part of the corresponding transverse processes, were resected. During this portion of the operation, a thick, creamy pus escaped from the region of the eleventh dorsal vertebra. Dissection along the body exposed the anterior surface where were found several sequestra, varying in size from 2.5 centimeters to 3.5 centimeters. The granulation tissue was curetted out and the surrounding bony tissue chiselled away. The anterior longitudinal ligament and overlying structures were sutured in layers, and the patient was placed in a plaster-of-Paris bed.

The general postoperative conditions were satisfactory, with total disappearance of pain. The wound healed by first intention. Immobilization by the Albee operation is to be performed.

DISCUSSION

Of the ten cases in which this technique of radical operation on the vertebrae has been used, all except two cases showed a healing by first intention. In one of the two cases, in which fistula had developed, its spontaneous closure occurred quite early and the patient was discharged in satisfactory condition a month after operation by the Albee method (Case 2). In the other case, discharge from the sinus has greatly diminished and there is evidence to indicate its spontaneous healing in the near future. In all the cases the complaints, for the relief of which the patients sought our aid, have disappeared following the radical operation. This result is especially significant when we consider the fact that all these cases were fairly well advanced, with destructive lesions of the bodies of the vertebrae demonstrable not only roentgenologically, but also at operation.

In dealing radically with these cases, it has been our practice first to make thorough, roentgenographic studies in order to obtain full information regarding the site and extent of the lesion, without which a proper approach could not be planned. In carrying out our technique on lumbar lesions, separation of the peritoneum has frequently been difficult on ac-

count of adhesions, but it has always been possible to accomplish it without any danger of infection.

In the radical treatment of the lesion we have felt that it is not sufficient merely to curet out the sequestrum and granulation, but that the eburnated bony wall of the lesion must also be thoroughly chiselled off, in order that subsequent regeneration of bone may be stimulated.

The fact that a cold abscess in Pott's disease heals by aspiration alone, during a course of successful conservative treatment, has been frequently observed. For this reason we have merely aspirated the contents of the abscess and obliterated any direct communication between the abscess and the vertebral lesion by suture of the abscess wall, and avoided a danger of secondary infection which might occur should we curet the abscess cavity or resect its wall. The results of this procedure (Cases 2, 3, 4, 7, and 8) were satisfactory, no reformation of the abscess having occurred in any case, except one.

In the repair of the defect in the body of the vertebra produced by its resection, we have either performed Albee's immobilization operation (Cases 1, 2, 3, 8, and 10) or inserted a bone transplant directly into the defect (Cases 4, 5, and 6); and in none of the cases so treated have we found an occurrence of, or increase of, already existing kyphosis. This outcome confirms our experimental results which showed that a slender piece of bone transplanted into the place of a vertebra is able to assume the weight-bearing function surprisingly well. Postoperative roentgenograms have further shown that, by chiselling off the eburnated bone forming the wall of a lesion, subsequent regeneration of bone is definitely enhanced. The transplant itself proliferates and becomes enlarged. These findings constitute a further clinical confirmation of the results of our experiments elsewhere reported. Even if recurrence of Pott's disease should follow our operation, we are certain that we have not done any real harm, since all that has actually been done, except the resection, is a surgical immobilization.

It appears to be quite logical to suppose that an operation at an early stage of the disease is desirable. It is certain, however, to be extremely difficult at an early stage to locate the lesion on the operating table; and, consequently, an early operation seems to us, at present, to be impossible. With the exception of cases with fistula, in which there is a danger of secondary infection, of cases with serious parenchymatous lesions, and of those in which the bodies of the vertebrae are extensively destroyed or more than two different parts of the spine are involved, the operation that we have presented here is applicable. That, with the above exceptions, the new radical method may be applied at any stage of the disease is shown by the satisfactory results obtained in our series, all of which were fairly advanced cases.

CONCLUSIONS

1. Disinfection of the field of operation must be most thorough.
2. For Pott's disease involving the lumbar vertebrae below and in-

cluding the second, our pararectal incision with extraperitoneal approach is advantageous, in that the resection of the body is comparatively easy and danger of contamination of the peritoneum is obviated.

3. For resection of the body of the twelfth dorsal or first lumbar vertebra, an oblique incision, similar to that of Bergmann's for nephrectomy, is accompanied by least hemorrhage.

4. A preliminary costotransversectomy enabled us to resect the body of a dorsal vertebra.

5. In performing a radical operation, it is not only necessary to be thorough in curettage, but the eburnated bony tissue of the immediate vicinity must also be chiselled off, as this manoeuver definitely favors the subsequent regeneration of bone.

6. A complicating cold abscess heals by mere aspiration of its contents and obliteration of its communication with the original focus.

7. In a series of experiments on the rabbits we have proved that when autotransplantation of bone is made into the place of a resected body of vertebra, a new bone is formed on the line of contact between the healthy vertebra and the transplant; the transplant itself grows by proliferation of its own tissue; and a weight of twenty kilograms is easily withstood by the transplanted segment of the spine.

8. A defect in the body of the vertebra caused by resection may be repaired either by an operation after the method of Albee or by a direct transplantation of a piece of the patient's own tibia or rib, without subsequent disturbance of weight-bearing function, as shown by the fact that a kyphosis does not develop, nor does any increase of a preexisting kyphosis occur.

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THE TREATMENT OF LEGG-CALVÉ-PERTHES DISEASE WITHOUT WEIGHT-BEARING *

BY MURRAY S. DANFORTH, M.D., PROVIDENCE, RHODE ISLAND

The question of the treatment of Legg-Calvé-Perthes disease is one of interest to all surgeons treating diseases of the hip joint. The author became interested in the treatment of this condition through the study of young patients in whom the diagnosis of tuberculosis of the hip was made during the period from 1909 to 1913. The patients were treated by means of traction in bed, traction in hip splints, or with plaster-of-Paris spicas. No weight-bearing was allowed. In a number of cases the final result was an apparently healed hip joint with motion through a nearly normal range. No roentgenograms of those patients are now available and no lantern slides. A restudy of the patients who had recovered with movable hips led to the belief that these particular patients had been suffering from the changes in the epiphysis of the femur, now classified as Legg-Calvé-Perthes disease. The results shown induced the author to use the same methods of treatment in subsequent cases in which the diagnosis of an epiphysitis seemed definite and was made at a time when roentgenographic studies were more satisfactory. Fortunately, lantern slides were made from the roentgenograms of some of these later patients; so that, while the original roentgenograms have been destroyed, a limited number of slides are available. The author has satisfactory lantern slides of two such cases and also has films showing the present condition of these patients, after a period of over ten years since they were discharged as cured. The slides of another fairly early case are also available, in which the same method was attempted, but where, through lack of cooperation on the part of the patient, the method was not carried out. Still more recently three cases have been treated by freedom from weight-bearing, which was maintained by keeping the patient in bed or in a wheel chair.

From a study of these six cases certain facts seem to be demonstrated, although it may be argued that six cases are not sufficient to prove the value of the method.

Studying Cases 1, 2, and 3, which have been under constant observation and supervision at the Wallum Lake Sanatorium of Rhode Island, it is evident that for the most part the clinical picture follows very closely the roentgenographic findings.

In Case 1 the diagnosis was made early and treatment was begun at once. This treatment consisted of rest in bed without weight-bearing, but without traction or other fixation. The roentgenograms later showed increased change in the head and with it increased clinical changes. As

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time went on, the head began to be more regularly calcified, and with this improvement the clinical findings became less abnormal. Finally the clinical examination was essentially negative and the roentgenographic appearance so nearly that of a normal hip that it is necessary to compare it with the other side to prove that it is not normal. This "cure" required four years, but no loss in education had resulted as, in the institution where the boy was, he had had all the advantages of an ordinary school. Further, it would seem that in a hip showing the structure and shape of the epiphysis such as is now present, late osteo-arthritic changes could not occur.

In Case 2, which was bilateral, the diagnosis was made very late in the instance of the right hip, and fairly late in the instance of the other hip. The clinical findings corresponded closely with what might be expected from the roentgenographic appearance, and the subsequent clinical course has followed the changes as shown by x-ray. It is of interest to note that, to a certain extent, the dome shapes of the epiphyses have been restored, although not completely.

Case 3, which was unilateral, was diagnosed earlier than Case 2. Here again the clinical findings followed the successive roentgenograms, and again the dome shape has reformed, though not completely.

Case 4 is one of the two patients who have been followed for a period of over ten years. The diagnosis was made early and non-weight-bearing instituted at once. This patient was kept ambulatory by means of a traction hip splint and crutches, using a high sole on the opposite shoe. Here again the clinical notes show that the course of the process followed the roentgenographic findings. No original films or plates are available, but from some of them lantern slides had been made and from these slides the prints have been produced. This is the reason for the rather poor illustrations that are offered. However, it seems essential to present them as otherwise there would be no positive evidence of the early condition. The last illustration of Case 4 was made from a roentgenogram taken recently, ten years after the patient was discharged. The patient has been doing heavy work, and has no symptoms and almost no demonstrable evidence of his early condition.

Case 5 is also one that has been followed for ten years since the boy was discharged as cured. It shows that a satisfactory result may be obtained even in a patient where, for a considerable time, the condition was so acute that rest in bed was not sufficient to overcome the muscle spasm and pain. It was therefore necessary to use a series of plaster-of-Paris spicas; during this time the patient was kept in bed. When the spasm and tenderness subsided, a traction hip splint was substituted and he became ambulatory. The result, ten years after discharge, is a hip that is almost perfectly normal although, since discharge, no restriction in use has been in force. These two cases, Cases 4 and 5, would tend to show that, in a so called cured hip, showing normal shape and bone structure, late changes, due to maladjustment of the head and acetabulum, do not occur.

CASE I (Figs. 1–14). George La R., aged six years.

FIG. 1

Roentgenogram, October 18, 1929. Very slight irregular decalcification of left capital epiphysis.

FIG. 2

Roentgenogram, January 18, 1930. Fragmentation of left capital epiphysis.

FIG. 3

Roentgenogram, May 12, 1930. More fragmentation and flattening of epiphysis, and broadening of neck.

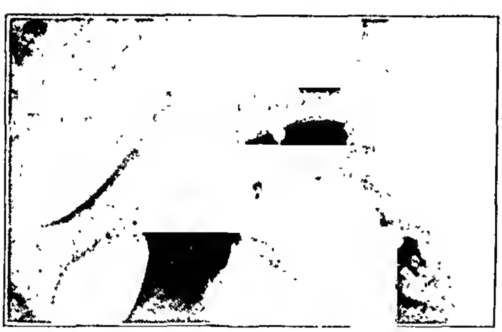

FIG. 4

Roentgenogram, July 9, 1930. Increased fragmentation.

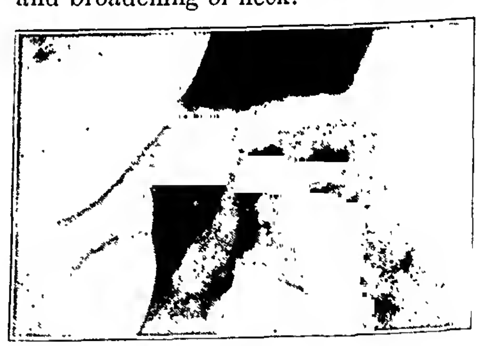

FIG. 5

Roentgenogram, November 20, 1930. Further decalcification of epiphysis.

FIG. 6

Roentgenogram, March 19, 1931. Less flattening of epiphysis.

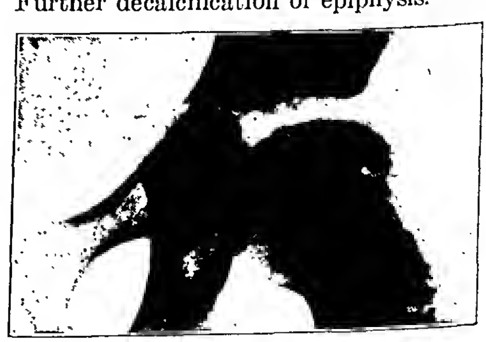

FIG. 7

Roentgenogram, July 19, 1931. Epiphysis approaching normal curve, and density more uniform.

CASE 1 (*Continued*)

FIG. 8

Roentgenogram, November 10, 1931. Surface of epiphysis smoother.

FIG. 9

Roentgenogram, March 11, 1932. Density and shape of epiphysis nearly normal.

FIG. 10

Roentgenogram, November 1, 1932. Head is still slightly broad, but bone structure appears normal.

FIG. 11

Roentgenogram, December 27, 1932. Hip appears normal, except for slight broadening of epiphysis and of neck.

FIG. 12

Roentgenogram, April 17, 1933. Less broadening of epiphysis and of neck.

FIG. 13

Roentgenogram, June 9, 1933. Hip appears normal except by comparison.

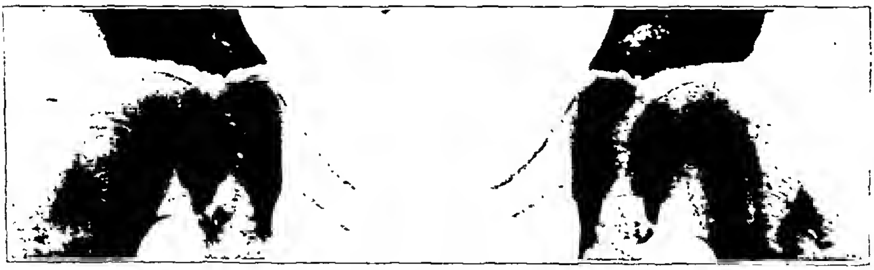

FIG. 14

Roentgenogram, December 30, 1933. Hip normal except by comparison.

Case 6 is taken as a single illustration of what has occurred in a number of patients where weight-bearing has been permitted or where, as in this case, weight was borne although the patient was ordered not to do so. At first not much damage was done, so little, in fact, that he was not put to bed. Later the marked change in the position and shape of the head was evident, and, although there is still not much clinical evidence of difficulty, it seems probable that changes will develop, since other patients with a similar history and similar fundamental changes show, at forty or forty-five years of age, very marked osteo-arthritis, with hips so painful that operative treatment is not only justified but seems absolutely necessary.

Cases 1 to 5 inclusive are given in as much detail as possible to show that, after sufficient restoration of the epiphysis is obtained, partial weight-bearing, and then complete weight-bearing, and finally unrestricted use of the hip may be allowed without danger of deformity resulting. These cases seem to present evidence that justifies the belief that a hip, during the period in which there is such alteration in the epiphysis, is not fit for weight-bearing. The author believes that it is the pressure made by bearing weight that causes the flattening and sliding of the epiphysis and that, even when some flattening and sliding or migration have occurred, a considerable restoration may be obtained by the institution of non-weight-bearing.

The cases illustrated show clearly that the head may resume much of its normal shape, structure, and position if no force is applied to distort it or cause it to migrate. Frequent roentgenograms, as well as very careful clinical observation, are essential to determine the time of beginning weight-bearing. The three cases treated by rest in bed without fixation or traction would seem to indicate that movement is not, as a rule, detrimental and may possibly be of importance in maintaining the nutrition of the surrounding tissues and possibly of the epiphysis as well. It is possible, too, that a consideration of these patients may furnish an argument in favor of earlier fixation of tuberculous hips in children.

Brief case histories are given:

Case 1. George La R., six years of age, when first seen October 2, 1929, had had symptoms in left hip of three months' duration. All motions of the left hip were slightly limited and the left leg was one-eighth of an inch short. The roentgenogram, taken on October 18, 1929, (Fig. 1) showed very slight irregular decalcification of the capital epiphysis. The patient was ordered to remain in bed, absolutely without weight-bearing.

January 18, 1930: The examination was the same, but definite fragmentation of the epiphysis was shown in the roentgenogram (Fig. 2).

May 12, 1930: The examination was the same but the roentgenogram (Fig. 3) showed more fragmentation of the epiphysis and at that time showed some flattening of the epiphysis and some broadening of the neck.

July 9, 1930: The hip showed less limitation of motions but the roentgenogram (Fig. 4) showed increased fragmentation.

November 20, 1930: On examination the hip was the same as before, except that the leg was one-quarter of an inch short and the roentgenogram (Fig. 5) showed further decalcification of the epiphysis.

March 19, 1931: All motions of the hip were still slightly limited, but the roentgenogram (Fig. 6) showed less flattening of the epiphysis.

July 19, 1931: The hip motions were still slightly limited, but the roentgenogram (Fig. 7) showed an epiphysis, the curve of which was approaching normal and its density was more uniform.

November 10, 1931: The motions of the hip were less limited and the leg only one-eighth of an inch short. The roentgenogram (Fig. 8) showed the surface of the epiphysis to be smoother. At that time the patient was allowed to go to school in a wheel chair. Up to that time he had had bedside instruction.

March 11, 1932: Examination of the hip showed slight limitation of external rotation and of hyperextension. All other motions were normal as compared with the opposite side. The roentgenogram (Fig. 9) showed the density and shape of the epiphysis nearly normal.

July 13, 1932: Examination was negative except for very slight limitation of hyperextension. Roentgenograms taken on this date showed the bone structure to be nearly normal, but the head was still slightly broader than normal.

November 1, 1932: The hip still showed slight limitation of hyperextension and the roentgenogram (Fig. 10) showed a head that was slightly broader than normal, but otherwise there was little difference in the two sides. At this time, approximately three years from the time treatment was begun, the boy was allowed partial weight-bearing.

December 27, 1932: All motions of the hip were free and the roentgenogram (Fig. 11) showed a normal head, except for slight broadening of the epiphysis and of the neck. The length of the weight-bearing periods was increased, but the boy still used crutches.

April 17, 1933: Hip motions continued to be free and the roentgenogram (Fig. 12) showed less broadening of the head and neck. At this time he was allowed to give up crutches part of the time (three and a half years from beginning of treatment).

June 9, 1933: The hip motions were all free; the lengths of the legs the same, and the patient walked without limp. The roentgenogram (Fig. 13) was normal except by comparison. From that time no restrictions were enforced (three years and eight months from beginning of treatment).

December 30, 1933: The examination of the hip was entirely negative; the legs were the same length; there was no limp in walking. Patient had had no restrictions for five months. Roentgenogram (Fig. 14) showed a hip that was normal except by comparison with the opposite side.

CASE 2. William G. was seven years old, when first seen July 10, 1929. Patient had had symptoms from the right hip for three years, for which no treatment had been given, and he had not complained of his left hip. Examination showed both legs to be the same length. The right hip showed marked limitation of all motions and the left hip moderate limitation of all motions. The roentgenogram (Fig. 15) showed marked flattening and broadening of the epiphysis and broadening of the neck of the right femur and marked irregularity of density with some flattening of the epiphysis and broadening of the neck of the left femur. The patient was ordered to rest in bed with absolutely no weight-bearing.

November 11, 1929: The hip motions were less limited, and the roentgenogram (Fig. 16) showed increased density of the epiphysis of each femur. Permission was given for the patient to go to school in a wheel chair, but with absolutely no weight-bearing.

March 29, 1930: The motions of both hips were freer and the roentgenogram (Fig. 17) showed more regular density of each epiphysis.

July 8, 1930: The motions of the hips were freer and the roentgenogram (Fig. 18) showed the epiphysis of the right hip to be thicker and the surface of the left capital epiphysis to be smoother.

November 20, 1930: The motions of both hips were freer and the roentgenogram (Fig. 19) showed each capital epiphysis to be slightly more dome-shaped.

CASE 2 (Figs. 15–28). William G., aged seven years. Right hip, symptoms of three years' duration; left hip, no complaint. Examination: Legs same length; markedly limited motions of right hip; moderate of left.

FIG. 15

Roentgenogram, July 10, 1929. Marked flattening and broadening of epiphysis and broadening of neck of right femur. Marked irregularity of density, with some flattening of epiphysis and broadening of neck of left femur.

FIG. 16

Roentgenogram, November 11, 1929. Increased density of epiphysis of each hip. Hip motions less limited.

FIG. 17

Roentgenogram, March 29, 1930. Density of each epiphysis more regular. Motions freer.

CASE 2 (*Continued*)

FIG. 18

Roentgenogram, July 8, 1930. Right epiphysis thicker. Articular surface of left smooth.

FIG. 19

Roentgenogram, November 20, 1930. Each epiphysis more dome-shaped.

FIG. 20

Roentgenogram, March 19, 1931. Articular surface of right hip smoother.

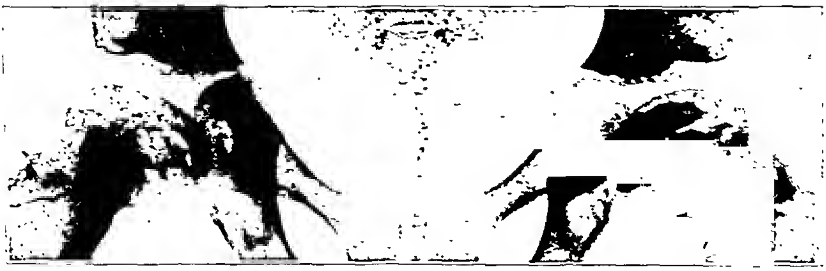

FIG. 21

Roentgenogram, July 9, 1931. Articular surface of right epiphysis smooth. Structure of left epiphysis nearly normal.

CASE 2 (*Continued*)

FIG. 22

Roentgenogram, November 10, 1931. Epiphyses unchanged since July 9, 1931.

FIG. 23

Roentgenogram, March 9, 1932. No change in epiphyses since July 9, 1931.

FIG. 24

Roentgenogram, July 13, 1932. Epiphysis of right hip more dome-shaped and more dense. Epiphysis of left hip nearer normal in shape and density.

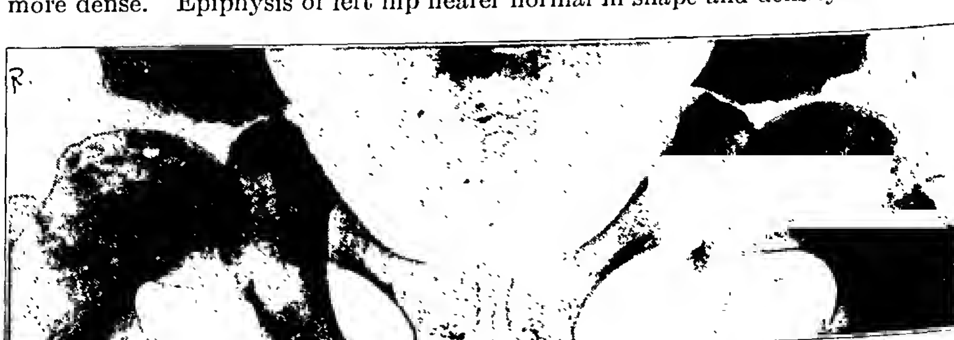

FIG. 25

Roentgenogram, October 29, 1932. Almost identical with that of July 13, 1932.

CASE 2 (*Continued*)

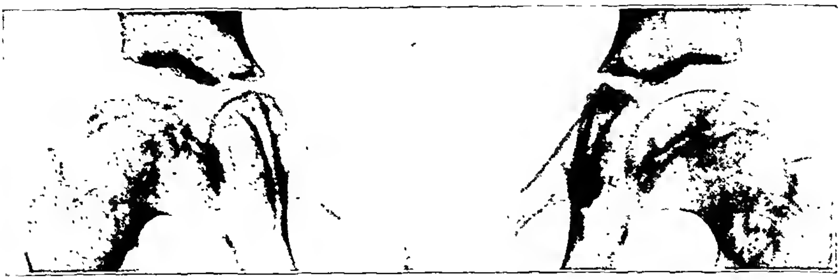

FIG. 26

Roentgenogram, June 6, 1933. Epiphysis of right hip is nearly normal in density, but is still flattened and broadened and neck is broad. Epiphysis of left hip shows nearly normal dome, but is broadened and neck is moderately broadened. All motions free except slight limitation of hyperextension of each hip.

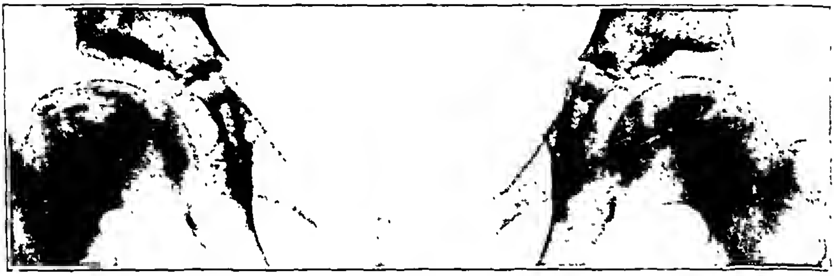

FIG. 27

Roentgenogram, July 27, 1933. Structure of right epiphysis nearly normal and of left almost normal. Hyperextension still slightly limited in each hip. Legs same length.

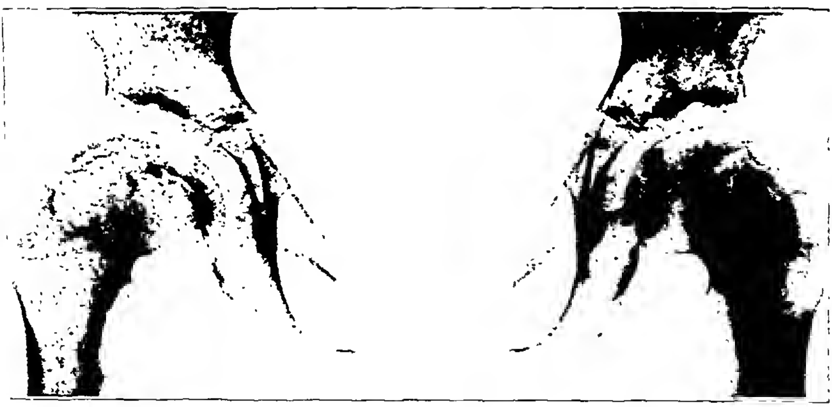

FIG. 28

Roentgenogram, October 10, 1933. No change appreciable in either epiphysis as compared with roentgenogram of July 27, 1933. Motions of both hips free, except slight limitation of hyperextension of both. Motions are painless. Legs same length.

CASE 3 (Figs. 29–40). Louis A., aged seven years.

FIG. 29

Roentgenogram, May 7, 1930. Irregular calcification of right hip.

FIG. 30

Roentgenogram, September 3, 1930. Right capital epiphysis irregular in shape and in calcification. Adjacent part of neck irregular in calcification.

FIG. 31

Roentgenogram, January 7, 1931. Epiphysis very irregular in shape and density.

FIG. 32

Roentgenogram, May 13, 1931. Epiphysis denser, but very irregular and apparently displaced slightly upward and outward.

FIG. 33

Roentgenogram, September 21, 1931. Epiphysis very irregular in shape and density.

FIG. 34

Roentgenogram, January 15, 1932. Epiphysis very irregular in density, but it is more dome-shaped and shows less evidence of slipping.

CASE 3 (*Continued*)

FIG. 35

Roentgenogram, May 6, 1932. Epiphysis more regular in shape and density.

FIG. 36

Roentgenogram, October 28, 1932. Density of epiphysis more regular, but articular surface still slightly rough.

FIG. 37

Roentgenogram, February 23, 1933. Epiphysis nearer normal in density. Position of epiphysis in relation to neck fair.

FIG. 38

Roentgenogram, June 6, 1933. Epiphysis irregular in density.

FIG. 39

Roentgenogram, July 25, 1933. Epiphysis still irregular in density, but slightly more dome-shaped and articular surface smoother.

FIG. 40

Roentgenogram, December 11, 1933. Epiphysis nearer normal in density.

March 19, 1931: Examination showed no change in the hip motions. The roentgenogram (Fig. 20) showed the surface of the right hip to be smoother.

July 9, 1931: The examination showed condition still unchanged from that of November 20, 1930, but the roentgenogram (Fig. 21) showed the surface of the right hip to be smooth and the structure of the left epiphysis to be nearly normal, though the shape was not normal.

November 10, 1931: The motions of the right hip were only slightly limited and the motions of the left normal. Legs were the same length. The roentgenogram (Fig. 22) showed no changes in the epiphyses from those seen July 9, 1931.

March 9, 1932: Examination showed all motions of the right hip to be free except for slight limitation of hyperextension and of internal rotation. The motions of the left hip were free. The roentgenogram (Fig. 23) showed no change since July 9, 1931.

July 13, 1932: Motions in both hips were free except for slight limitation of hyperextension in each. Roentgenogram (Fig. 24) showed the epiphysis of the right hip more dome-shaped and more dense and the epiphysis of the left nearer normal in shape and density.

October 29, 1932: No appreciable changes were evident by examination from those seen July 13, 1932, except that the right leg was one-quarter of an inch short. The roentgenographic appearance (Fig. 25) was unchanged from that of July 13, 1932.

June 6, 1933: All motions of both hips were free except for slight limitation of hyperextension in each. Roentgenogram (Fig. 26) showed the right epiphysis nearly normal in density but still flattened and broadened and the neck broadened, while the left showed a nearly normal, dome shape of the epiphysis, though it was still broadened and the neck was broadened.

July 27, 1933: Hyperextension of each hip was still slightly limited; legs were the same length. The roentgenogram (Fig. 27) showed the bone structure of the right epiphysis nearer normal and that of the left epiphysis almost normal. At this time the patient was allowed partial weight-bearing with crutches (four years from the time treatment was begun).

October 10, 1933: Patient had been bearing partial weight for three months. All motions of both hips were free except for slight limitation of hyperextension in each. The hips were painless; and the legs the same length. The roentgenogram (Fig. 28) showed no appreciable changes from those evident on July 27, 1933.

Case 3. Louis A. was seven years old when first seen on May 7, 1930. He had had symptoms in the right hip of three months' duration. Examination showed all motions of the right hip limited and the right leg one-quarter to three-eighths of an inch short. The roentgenogram (Fig. 29) showed irregular calcification of the right capital epiphysis. The boy was ordered to rest in bed, with no weight-bearing but no fixation.

September 3, 1930: All motions of the right hip were limited and the hip was slightly sensitive. The leg was one-quarter of an inch short. The roentgenogram (Fig. 30) showed the capital epiphysis irregular in shape and in calcification, and the adjacent part of the neck was irregular in calcification.

January 7, 1931: All motions of the right hip were considerably limited, and the hip showed five degrees of permanent flexion. The leg was three-eighths of an inch short. Roentgenogram (Fig. 31) showed the epiphysis very irregular in shape and density.

May 13, 1931: All motions of the hip were much limited, and the hip showed ten degrees of permanent flexion. The leg was three-eighths of an inch short. The roentgenogram (Fig. 32) showed the epiphysis to be denser, but very irregular in shape and apparently displaced slightly upward and outward.

September 21, 1931: All motions of the hip were limited and the hip showed fifteen degrees of permanent flexion. The leg was one-half inch short. The roentgenogram (Fig. 33) showed an epiphysis very irregular in shape and density.

January 15, 1932: All motions of the hip were more free, but the hip still showed ten degrees of permanent flexion. The leg was three-eighths of an inch short. The roent-

genogram (Fig. 34) showed an epiphysis very irregular in density, but it was more dome-shaped and showed less evidence of slipping.

May 6, 1932: All motions of the hip were nearly normal except for ten degrees of permanent flexion. The leg was three-eighths of an inch short. The roentgenogram (Fig. 35) showed an epiphysis more regular in shape and density.

October 28, 1932: All motions of the hip were free except for slight limitation of abduction. The leg was three-eighths of an inch short. The roentgenogram (Fig. 36) showed more regular density of the epiphysis, but the surface was still slightly rough.

February 23, 1933: The hip showed slight limitation of hyperextension and of abduction. The leg was three-eighths of an inch short. The roentgenogram (Fig. 37) showed an epiphysis nearer normal in density and its position in relation to the neck nearer normal.

June 6, 1933: All motions of the hip were free, but the leg was still three-eighths of an inch short. The roentgenogram (Fig. 38) showed an epiphysis somewhat irregular in density.

July 25, 1933: All motions of the hip were free, but the leg was still three-eighths of an inch short. The roentgenogram (Fig. 39) showed an epiphysis still irregular in density, but it was more dome-shaped and the surface was smoother.

December 11, 1933: All motions of the hip were free. The leg was still three-eighths of an inch short. The roentgenogram (Fig. 40) showed an epiphysis nearer normal in density and shape with something of a dome. Clinically and by roentgenographic examination the patient is nearly ready for partial weight-bearing after three and one-half years of treatment.

CASE 4. William H. was nine and one-twelfth years old when first seen on August 4, 1921. He had had symptoms from his right hip for about one year. Examination showed all motions of the right hip slightly limited and the right leg one-half inch short. Roentgenogram (Fig. 41) showed a capital epiphysis very irregular in shape and density, but not much flattened. The neck was slightly broadened and very irregular in density. The patient was given crutches and a high sole on the opposite shoe and was directed not to bear weight, a direction that he followed very carefully.

January 6, 1922: All motions of the hip were slightly limited, and the leg was three-eighths of an inch short. Roentgenogram (Fig. 42) showed an epiphysis very irregular in shape and density and considerably flattened, while the neck was broadened.

March 31, 1922: The hip motions were very slightly limited and the leg only one-quarter of an inch short. The roentgenogram (Fig. 43) showed the epiphysis to be less flattened.

June 21, 1922: The hip motions were all free, but the leg was still one-quarter of an inch short. Roentgenogram (Fig. 44) showed the epiphysis to be slightly less flat.

November 27, 1922: All motions of the hip were free except for very slight limitation of abduction. The leg was one-quarter of an inch short. The roentgenogram (Fig. 45) showed an epiphysis more dome-shaped and more regular in density.

April 2, 1923: All motions of the hip were free except for very slight limitation of abduction; the leg was one-quarter of an inch short. The roentgenogram (Fig. 46) showed an epiphysis nearly normal in density and the surface smooth though somewhat flattened. Orders were then given for the patient to continue with crutches and a high sole and no weight-bearing for six weeks more, and then to begin partial weight-bearing with crutches. These were carried out and shortly full weight-bearing was allowed without restrictions (duration of treatment, two years).

December 30, 1933: A final check-up was made ten years after discharge. The patient reported that he had had no symptoms for ten years, although there had been no restrictions in his activities and he had done heavy work, part of the time as a truck driver. Examination showed all motions of the hip as free as on the opposite side, except for very slight limitation of external rotation when the hip was flexed to ninety degrees. The roentgenogram (Fig. 47) showed an epiphysis that was normal except by comparison with the opposite side.

CASE 4 (Figs. 41–47). William H., nine years old. (Illustrations of this case, except the final one, are taken from lantern slides, as the original roentgenograms have been destroyed.)

FIG. 41

Roentgenogram, August 4, 1921. Epiphysis very irregular in shape and density, but not much flattened. Neck broadened and very irregular in density.

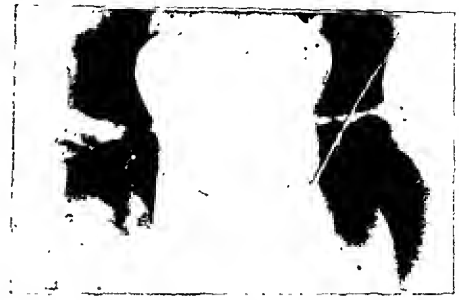

FIG. 42

Roentgenogram, January 6, 1922. Epiphysis very irregular in shape and density and considerably flattened. Neck broadened.

FIG. 43

Roentgenogram, March 31, 1922. Epiphysis less flattened.

FIG. 44

Roentgenogram, June 21, 1922. Epiphysis slightly less flat.

FIG. 45

Roentgenogram, November 27, 1922. Epiphysis more dome-shaped and more regular in density.

FIG. 46

Roentgenogram, April 2, 1923. Epiphysis nearly normal in density, and surface smooth, though flattened.

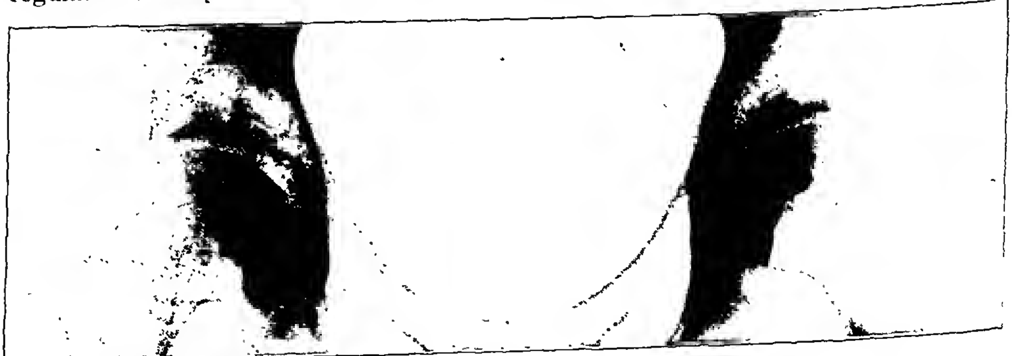

FIG. 47

Roentgenogram, December 30, 1933. Epiphysis nearly normal except by comparison.

CASE 5 (Figs. 48–54). Harold Z., five years old. (The illustrations of this case, except the final one, are made from lantern slides, as the original roentgenograms have been destroyed.)

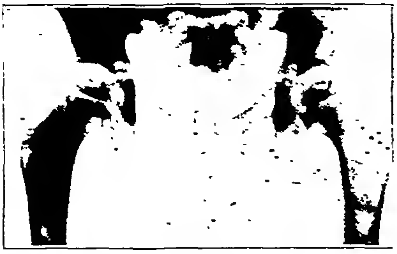

FIG. 48

Roentgenogram, August 9, 1921. Epiphysis of left femur slightly less dense.

FIG. 49

Roentgenogram, October 11, 1921. Epiphysis slightly smaller and less dense.

FIG. 50

Roentgenogram, January 9, 1922. Some fragmentation of epiphysis with some flattening, also some broadening of the neck.

FIG. 51

Roentgenogram, September 12, 1922. Some fragmentation of epiphysis and irregular density of the neck.

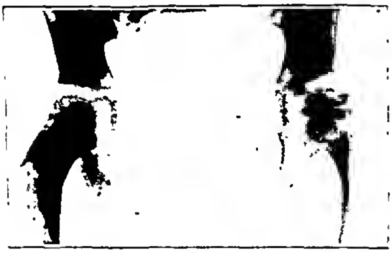

FIG. 52

Roentgenogram, April 19, 1923. Epiphysis has increased in size, but is still irregular in density and flatter than normal.

FIG. 53

Roentgenogram, September 26, 1923. Epiphysis slightly more than normal size, somewhat flattened, but density fairly regular.

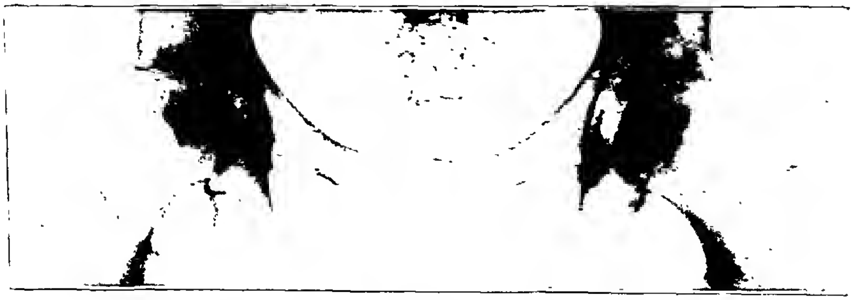

FIG. 54

January 4, 1934. Epiphysis almost normal in shape, structure, and position.

CASE 5. Harold Z. was five years old when first seen on August 9, 1921. There had been symptoms in the left leg of five weeks' duration. Examination showed all motions of left hip slightly limited and guarded (sensitive) except flexion which was entirely free. The left leg was one-quarter of an inch short. The roentgenogram (Fig. 48) showed slight lessening of density of the capital epiphysis. The patient was ordered to rest in bed absolutely without weight-bearing.

October 11, 1921: The patient had not been kept in bed, and had used his leg. Examination showed more limitation of all motions and more pain; the leg was three-eighths of an inch short. Roentgenogram (Fig. 49) showed the epiphysis to be slightly smaller and less dense. Again rest in bed was directed.

January 9, 1922: Clinically the hip had not improved and showed all motions markedly limited; there was ten degrees of permanent flexion. The legs were the same length. The roentgenogram (Fig. 50) showed some fragmentation of the epiphysis with some flattening and also some broadening of the neck. Rest in bed was still attempted, but without improvement in symptoms, and hip spicas were finally applied; after seven months the hip was less sensitive. Meantime the boy was kept in bed. Roentgenogram on September 12, 1922 (Fig. 51), showed some fragmentation of the epiphysis and in addition irregular density of the neck. The spicas were continued until December 4, 1922 (about ten months altogether), and then a traction hip splint was applied and the patient became ambulatory, using crutches and with a high sole on the opposite shoe.

April 19, 1923: The patient had worn a traction hip splint for about four months and the motions were more free. The roentgenogram (Fig. 52) showed an epiphysis that had increased in size but was still irregular in density and flatter than normal.

September 26, 1923: The hip motions were only slightly limited and were not sensitive. The leg was one-quarter of an inch short. The roentgenogram (Fig. 53) showed an epiphysis slightly larger than normal and with fairly regular density, but in shape somewhat flattened. The hip splint was continued until December 17, 1923, when partial weight-bearing was allowed; and, from March 25, 1924, full weight-bearing was permitted. This made a period of nearly three years under treatment.

January 4, 1934: About nine years after discharge a final check-up was made that showed no differences between the two hips on clinical examination. The legs measured the same in length and the boy walked and ran without limp and could carry on all his usual activities without restrictions. The roentgenogram (Fig. 54) showed an epiphysis almost normal in shape, structure, and position.

CASE 6. Stuart S. was six years old when first seen, March 26, 1923. He had had symptoms from the left leg of four and one-half months' duration. Examination of left hip showed all motions of the hip slightly limited except flexion which was free. The hip was sensitive. The legs were the same length. The roentgenogram (Fig. 55) showed the left capital epiphysis flattened and irregular in density. The patient was given crutches and a high sole on his opposite shoe and directed to bear absolutely no weight on the affected side.

September 28, 1923: The hip motions were all slightly limited except flexion which was free; all motions were painless. The legs were the same length. The roentgenogram (Fig. 56) showed fragmentation and flattening of the epiphysis and some broadening of the neck of the femur which was irregular in density. Crutches and a high sole were continued.

February 3, 1927: In the interval of three and one-half years the patient did a great deal of weight-bearing, probably even from the first, as it was impossible to get cooperation. Nevertheless all motions of the hip were free except for slight limitation of abduction and hyperextension. The roentgenogram at this time (Fig. 57) showed the epiphysis to be very broad, flat, and thin, and the neck very broad. No further attempt at prevention of weight-bearing was made.

November 21, 1927: Examination showed all motions painless and all free except for slight limitation of abduction and of hyperextension. The leg was only one-eighth of

Case 6 (Figs. 55–61). Stuart S., six years old.

Fig. 55

Roentgenogram, March 26, 1923. Epiphysis of left femur flattened and irregular in density.

Fig. 57

Roentgenogram, February 3, 1927. Epiphysis very broad, flat, and thin. Neck very broad.

Fig. 56

Roentgenogram, September 28, 1923. Epiphysis shows fragmentation and flattening, and neck of femur is slightly broadened and irregular in density.

Fig. 58

Roentgenogram, November 21, 1927. Epiphysis still broad, flat, and irregular in density. Neck very broad and irregular in density.

Fig. 59

Roentgenogram, December 27, 1928. Epiphysis very flat, broad, and thin. Neck very broad and deformed. Bone structure nearly normal.

Fig. 60

Roentgenogram, February 19, 1930. Head and neck slightly more deformed.

Fig. 61

Roentgenogram, September 17, 1931. Head and neck slightly more deformed.

an inch short and the patient walked without limp. The roentgenogram (Fig. 58) showed an epiphysis that was still flat and broad and irregular in density, and the neck was broad and irregular in density.

December 27, 1928: All motions of the hip were painless and all free except for slight limitation of abduction and hyperextension, necessitating some restriction of activities. Roentgenogram (Fig. 59) showed an epiphysis very flat and broad and thin and the neck broad and deformed. The bone structure, however, was nearly normal, indicating a healed process.

February 19, 1930: All motions of the hip were painless and all free except for slight limitation of abduction and of hyperextension. The leg was five-eighths of an inch short and the patient walked with a slight limp. The roentgenogram (Fig. 60) showed the head and neck a little more deformed.

September 17, 1931: Internal rotation, abduction, and hyperextension of the hip were considerably limited; all motions were painless. The leg was three-quarters of an inch short. He walked with a slight painless limp. The roentgenogram (Fig. 61) showed a little more deformity of the head and neck.

SUMMARY

Cases 1, 2, and 3 illustrate the course and early results in patients treated without apparatus but without weight-bearing. Cases 4 and 5 show the late results of treatment without weight-bearing but with an ambulatory traction splint or with crutches and a high sole. After ten years no deformity had developed. Case 6 illustrates the result where, in spite of directions to the contrary, weight was borne almost constantly.

The illustrations present a plea for non-weight-bearing in Legg-Calvé-Perthes disease until the bone structure has become normal.

THE STATUS OF KOCHER'S METHOD OF REDUCING RECENT ANTERIOR DISLOCATION OF THE SHOULDER*

BY JOSEPH NASH, M.D., F.A.C.S., NEW YORK, N. Y.

Nearly every surgical text gives a different description of the Kocher method. Over twenty years ago Martinet [1] noted the same state of affairs: "The different descriptions do not agree with one another and these descriptions do not correspond with the original description". Therefore, before discussing the opinions held as to its value, it is well to repeat the original description of the method as given by Kocher [2]: "*Pressing the arm, with elbow flexed, close to the side of the body, outward rotation until a resistance is encountered, elevation forward of the externally rotated arm in the sagittal plane as far as it will go, and finally slow inward rotation.*" This is the Kocher method, and it was intended for use only in *recent anterior* dislocations of the shoulder. The following discussion will be confined to its use in connection with this one type of case, although Kocher later considered the method applicable to old dislocations as well. (In one case of dislocation of eight weeks' duration in a man of seventy-nine years, Kocher induced fracture of the shaft of the humerus; in twelve cases, in which the duration of the dislocation ranged from three weeks to four months, he accomplished reduction successfully.) It should be noted that Kocher does *not* prescribe traction as part of his method. He does not even mention traction in connection with it.

Table I contains a list of fifteen authors who decidedly favor the original Kocher method. Kaufmann, Bach, and Ceppi were pupils of Kocher and perhaps Kaufmann's phenomenal success with the method (only three failures in 300 cases during forty-seven years) is attributable to special skill acquired under the guidance of the inventor. It is noted that several writers who favor the method disagree with its author as to the relative importance of muscles and capsule in opposing reduction, and as to the frequency of complicating fracture of the greater tubercle.

That the original method did not prove entirely satisfactory is indicated by the fact that modifications (Table II) were suggested, consisting mainly in the addition of the recumbent posture, traction throughout the procedure, and overadduction of the arm, so as to carry the elbow across the front of the chest to the mid-sternal line.

In Table III are listed six writers who reject the method, with their reasons for doing so. From the fact that this list is short, one might think that the profession in general has found the method very satisfactory. However, from a fairly complete survey of the literature, the writer finds that forty-six "new" methods for reducing a dislocated shoulder have been proposed since Kocher's first publication on the sub-

* From the Department of Surgery, New York University, and the Third Surgical Division, Bellevue Hospital.

TABLE I

AUTHORS WHO ACCEPT KOCHER'S METHOD

Year	Author	No. of Cases	Remarks
1881	C. Kaufmann	14	Pupil of Kocher.
1882	*Körte	Not stated	Fracture of greater tubercle more frequent than Kocher believed.
1883	Heath	5	Chloroform given in three cases.
1885	Stimson	Not stated	"Appears well adapted to avoid the dangers to the vessels."
1888	Norton	11	Unsuccessful in one other case.
1889	Boerstler	1	
1890	*Hennequin	Not stated	Muscles are as important as is capsule as obstacle to reduction.
1890	Beesley	2	
1898	*Waterston	Not stated	Muscles are important, not coracohumeral band.
1906	Faucon	11	Unsuccessful in two other cases.
1906	Bach	Not stated	Cadaver study under direction of Kocher.
1909	Battle	1	Successful, but tearing of axillary vein resulted in death.
1924	Schlaepfer	113	Kocher's method "usually satisfactory".
1926	*C. Kaufmann	300 (in forty-seven years)	Fracture of greater tubercle is more frequent and the capsular tear is usually greater than Kocher supposed. Only failed in three cases. Pupil of Kocher.
1927	Ceppi	Not stated	Pupil of Kocher.
1927	Roux	Not stated	Succeeds only in strictly subcoracoid cases.

* Differs with Kocher as to rationale.

TABLE II

AUTHORS WHO MODIFY KOCHER'S METHOD

Year	Author	No. of Cases	Modification	Remarks
1883	Jersey	20	Traction.	
1889	Powers	98	Recumbent position and traction.	Failed in twenty-eight other cases. Muscles hinder reduction.
1891	Woolmer	1	Elbow carried across front of chest.	
1891	Honan	2	Recumbent.	
1893	Thomas	24	Recumbent, traction, elbow carried in across chest.	Six other cases failed.
1894	Morton	Not stated	Recumbent, elbow carried in across chest.	
1895	Mermet	Not stated	Recumbent.	Pain and syncope frequent.
1898	Boyd	Not stated	Recumbent.	
1906	Robineau	Not stated	Elbow carried in across chest.	
1910	Gallois	Not stated	Patient's hand on surgeon's shoulder, elbow carried in across front of chest, last step done very slowly.	In practice, Kocher's method usually fails and then the ancient method of traction is used.
1910	Delorme	Not stated	Traction.	Contrary to Kocher, does not believe anterior part of capsule opposes reduction.
1927	Best	Not stated	Traction.	

TABLE III

AUTHORS WHO REJECT KOCHER'S METHOD

Year	Author	Remarks
1903	Vaughn	Very painful, danger of injury to tissues.
1910	Martinet	Painful. "The different descriptions do not agree with one another. . . . These descriptions do not correspond with the classical description. . . . A procedure difficult to apply, whose indications are very restricted, and which is uncertain and dangerous."
1918	Cosens	Painful. Frequently fails.
1919	Constantini	Fails too often, even in the hands of the most expert. Is too complex.
1928	Meyer	Danger of causing fracture is too great.
1930	Rixford	Danger of causing fracture, saw several such instances, one his own.

ject,—that is, between 1870 and 1926 (Table IV). Twenty of these methods involve traction outward; eight, downward; and seven, upward. The remaining eleven methods do not involve traction,—six of them consist essentially of adduction of the arm over a fulcrum, and five belong to a class which might be described as "trick" methods. It is likely that if Kocher's method had been found highly effective there would not have been so many attempts to find a substitute for it.

Kocher indicates that at the time he proposed his method his personal clinical experience with dislocation of the shoulder was limited to eleven cases, in less than half of which he had employed his new procedure. In the experimental investigations on which the method is based, he undertook to produce a "typical" dislocation by deliberately incising the joint capsule at a particular part and to a definite extent, and then dislocating the humeral head by means of a manoeuver obviously adapted to this incision. "An incision was made in the axilla over the head of the humerus parallel with the anatomical neck, opening the capsule from the lower border of the subscapularis to the origin of the triceps. The arm was then forcibly raised to the vertical and pushed downward. On lowering it I found a complete subcoracoid dislocation." He then determines from the dissected part what sort of manipulation is required to replace the bone after it has been artificially displaced in this manner. It should be emphasized that Kocher bases his method entirely on this type of experiment.

Kocher assumes that the tear in the capsule is practically always in the antero-inferior part of the joint, while the other parts remain intact, for both his experiments and his proposed method rest upon this assumption. Most writers of the present time seem to make the same supposition. In a fairly complete search of the literature since 1880, the writer has found eight autopsy reports of cases of dislocated shoulder in which the damage to the capsule is clearly stated[3]. The tear was antero-inferior in only three cases. In two cases, it was anterosuperior (in one of these cases the humeral head did not protrude through the small tear); and there was no tear at all in the remaining three cases, although in one of

TABLE IV

"NEW METHODS" OF REDUCING DISLOCATION OF THE SHOULDER PROPOSED SINCE 1870

Essential Feature of Method									
Lateral Traction		Downward Traction		Upward Traction		Adduction Over a Fulcrum (No Traction)		"Trick" Methods (No Traction)	
Author	*Date*	*Author*	*Date*	*Author*	*Date*	*Author*	*Date*	*Author*	*Date*
Despres	1877	Jones	1879	Chenowith	1883	Purdy	1888	Greene	1881
Lawton	1881	Cole	1891	Huguier	1905	Hallaran	1895	Hussey	1887
Hicks	1881	Brennsohn	1903	Chipman	1906	Ferrier	1895	Michie	1887
Macphail	1881	Garms	1905	Caesar	1914	Wagner	1911	Marcille	1913
Macleod	1882	Spitzy	1916	Angelvin	1915	Bentzon	1921	Newton	1926
Kelly	1882	Turner	1918	Cosens	1918	Newton	1926		
Longfield	1887	Haller	1919	Malis	1924				
Parkinson	1887	Constantini	1919						
Lloyd	1887								
Owen	1887								
Dutch	1887								
White	1891								
Berthaut	1905								
Rapoutova	1906								
Marion	1906								
Schickhold	1909								
Doyen	1911								
Barbet	1918								
Dshanilidze	1924								
Stevens	1926								

these cases the capsule was detached from the anterior glenoid edge, but was still continuous with the periosteum of the scapula. These findings indicate that assumptions as to the exact nature and location of the injury to the capsule in a given case of dislocation of the shoulder may not be as well founded as Kocher and others have supposed.

Under the conditions of his experiment, Kocher finds that "the undamaged upper part of the anterior wall of the capsule, the part attached to the upper edge of the tendon of the subscapularis muscle and lying between the latter and the biceps tendon, undergoes a rotation and is turned into a cord which runs diagonally from the upper edge of the glenoid attachment of the capsule to the lower humeral attachment, passing beneath the tendon of the subscapularis and in part blending with the upper edge of the latter. This relation of the anterosuperior part of the capsule I have found constantly, and it is to be assumed that this condition is the rule." On this assumption, Kocher assigns an important rôle to the portion of the capsule in question in his proposed method of reduction. "The first step, in which the arm is drawn to the side of the body, causes the superior part of the capsule to become stretched still tighter than it was so that a firmer fulcrum point is gained, about which the head can be rotated outward. By this outward rotation the posterior wall of the capsule, which is continuous with the cord, is elevated off the glenoid, and there is no other method by which this might be accomplished so effectively,—*i. e.*, by which the tear in the capsule might be made to gape so widely."

The belief that the strong upper part of the capsule (coracohumeral ligament) always remains intact in clinical dislocation has been questioned. Schüller[4] expresses a view just contrary to that of Kocher: "The capsular tear in by far the majority of typical luxations is so large that difficulty of reduction can in no way be due to it." Kaufmann[5], pupil of Kocher and a staunch apostle of his method since 1881, states: "Kocher had supposed that the upper part of the joint capsule remained intact. This supposition was not subsequently confirmed. We know that tearing of the ligamentum coracohumerale is possible even without damage to the tuberculum majus, and then it escapes x-ray diagnosis." Although he continues to advocate the method, Kaufmann is forced to speculate anew as to its rationale as far as the damage to the capsule is concerned.

The coracohumeral ligament is inserted into the front of the greater tubercle of the humerus, and so is almost certain to suffer injury or relaxation whenever the tubercle is fractured. Then the mechanism of reduction described by Kocher would be impossible. Evidence that fracture of the greater tubercle is rather frequent in dislocation of the shoulder will be given presently.

It is a fundamental postulate of the rationale of the Kocher method that reduction can be attained as well without relaxation of the muscles as otherwise. Kocher cites earlier studies by various investigators as to the relative importance of the joint capsule and the muscles in opposing re-

duction, and, in the face of conflicting evidence and opinions, adopts the following tenet: "In spite of all, it remains a valid principle in dislocation of the shoulder that reduction can be accomplished through relaxation of the stretched remainder of the capsule and opening up of the tear in the capsule, even without relaxation of the muscles." From his observations on the cadaver he proceeds to describe in detail which muscles are stretched and which are relaxed in a dislocation of the shoulder; and implies that the same conditions obtain in the living, since he professedly bases his clinical method upon his experimental studies.

Hennequin[6], a proponent of the Kocher method, states: "The facts of practical surgery are a puissant argument in favor of the muscular theory, for anaesthetics paralyze the muscles but have no action on the ligaments. . . . Experiments on the cadaver can never supersede clinical facts when there is a question of lesions in which the muscles cannot remain inactive." Dagron[7], holding that "muscular contraction is the sole cause of the hindrance to the return of the head into the glenoid cavity", recommends massage for inducing relaxation. Saquet[8] reports a case in which reduction occurred under the influence of massage applied ten minutes after the accident with the object of easing the pain.

Kocher accords the deltoid muscle special mention, as follows: "Regarding the deltoid muscle, a peculiarity deserves attention which, as far as I know, has not hitherto been appreciated by anatomists. If one studies anew the deltoid in subcoracoid dislocations in the living or on the cadaver, one finds springing from the most lateral part of the acromion a rounded cord extending to the insertion in the arm, which is more tense than all the other parts of the muscle. This cord appears in the preparation as a rounded tendon running in the muscle, lying on its inner surface, which can be isolated without any difficulty. It is clear that one might take it for the displaced biceps tendon in the living if one does not follow it to its insertion. . . . It is obvious that the deltoid . . . in determining the difficulty of reduction is of interest first because of its fibrous component and second on account of its muscle fibers." He asserts that "there can be no question but that it [the tendinous cord] by its tension, and in conjunction with the capsule, aids in holding the [dislocated] head of the bone against the anterior edge of the glenoid".

A strong inelastic tendon, completely traversing the length of a muscle and fastened both to the origin and to the insertion would appear to be a very exceptional arrangement, hardly consistent with the normal functioning of a skeletal muscle. Because of the clinical importance attributed to it by Kocher, this anatomical finding has been reexamined. Gray's Anatomy (1930) describes "tendinous intersections, generally four in number" but does not state that these traverse the entire length of the muscle. The writer, on dissecting sixty deltoid muscles in thirty adult subjects, found that the tendinous cords of origin varied in number (from two to five) and in thickness with the muscular development of the subject, but that in every instance, when traced dis-

tally, they became narrower and completely disappeared in the substance of the muscle, none reaching the tendon of insertion. These findings do not support Kocher's statement that a tendinous component of the deltoid muscle is of importance in opposing reduction.

Kocher's manoeuver requires an "impingement of the greater tubercle or of the posterior part of the anatomical neck against the anterior glenoid edge". As this impingement is interfered with if the part is fractured, Kocher places fracture of the greater tubercle among the contra-indications to his method, and states: "The question as to the frequency of avulsion of the greater tubercle is of importance in the mechanism of reduction." As direct evidence that this complicating fracture is usually absent, he cites three autopsy reports from the literature and Malgaigne's statement (based on a few autopsies) that "as a rule" it is absent. It is generally believed that fracture of the greater tubercle complicates dislocation of the shoulder in only a small minority of cases, but this is not the case. Gubler[9] finds fracture of the greater tubercle in seven per cent. of cases of dislocated shoulder. Schlaepfer[10] finds it in seven and four-tenths per cent. of 114 cases observed between 1899 and 1919, the diagnosis being made, no doubt, without roentgenographic aid in the earlier cases. Meyer[11] gives fourteen per cent. without stating the evidence supporting that figure. The greater tubercle is fractured in "most dissected cases" according to Körte[3]; "in over half of all cases" according to Bardenhauer[12]. Kaufmann[5], faithful disciple of Kocher and ardent protagonist of his method, concedes that "x-ray studies have established the great frequency of damage to the tubercle".

Thirteen post-mortem reports[13] found in the literature since 1880 are explicit on this point. An associated incomplete fracture of the humerus was found in ten cases. In four of these cases the fracture was at the anatomical neck or articular cartilage. In six cases the greater tubercle was affected,—being merely chipped in one case, more extensively fractured in two cases, and completely torn off in three cases.

On the Third Surgical Division of Bellevue Hospital, 127 cases of primary recent anterior dislocation of the shoulder were treated during the ten-year period 1922–1931, inclusive. In twenty-eight cases, or twenty-two per cent., fracture of the greater tubercle of the humerus was found on roentgenographic examination. It is of interest that in five cases the first roentgenogram, taken with the portable ward machine, failed to reveal the fracture, which was detected only on subsequent examination in the x-ray department under more favorable conditions. The average age of the entire group was fifty-two and eight-tenths years; of those with fracture of the tubercle, forty-eight and nine-tenths years. (In addition, there were ten cases of recurrent dislocation in which there was no associated fracture.)

Kocher seeks to establish the rarity of fracture of the greater tubercle by indulging in the following "logic": "Since [major premise] healing of

the greater tubercle is usually imperfect, while [minor premise] residual impairments of function after dislocations of the shoulder are nevertheless rather exceptional, we may conclude that dislocation is in most cases uncomplicated by this fracture." Aside from the gross technical errors exhibited in this syllogism, it may be said that the substance of the major premise has not been confirmed; in fact, over fifty years later, a representative textbook of surgery[14] states concerning fractures of the greater tubercle of the humerus: "Satisfactory healing usually occurs". And, contrary to the minor premise, the same textbook states that permanent disability, following shoulder dislocation, is frequent. That Kocher did not encounter fracture of the tubercle in his cadaver experiments is not surprising considering the stereotyped incision and rather gentle manipulation by which he induced dislocation, and the absence of muscular action in the dead subject.

In modern practice, in whatever method is selected, the use of some form of traction for the reduction of a dislocated shoulder is nearly universal, and is the chief requisite. Traction is employed in the treatment of fractures and dislocations to "fatigue the muscles", according to current teaching, which ignores the known physiological mechanisms which regulate the tonus of skeletal muscle. In a tonically contracted muscle, the various muscle fibers act in rotation, intermittently and asynchronously. Hence, fatigue is markedly delayed because one group of fibers can rest while the neighboring fibers are contracting.

The tone of striated muscle is neurogenic,—that is, it depends entirely upon stimuli coming to the muscle from the central nervous system; and it is reflex in that the nerve centers emit the tonic impulses in response to afferent impulses coming into the centers along afferent nerve fibers. One source of these afferent impulses is the sensory muscle spindles in the muscles themselves, stimulation of which by traction reflexly induces shortening or lengthening of the muscle. The application of a small pull to an innervated muscle excites it to resist the pull (shortening reaction). The application of a considerable pull, especially if continued for some time, stimulates a different set of sensory receptors in the muscle, which results in reflex inhibition in the tonus of the muscle (lengthening reaction). Muscle spindles have been found to continue to discharge a regular series of afferent impulses in response to a prolonged unvarying stimulus, such as is produced by steady traction. In this respect they differ from other sensory end organs, such as those of touch, which show only a transient response (as measured by action currents) to a continued stimulus,—that is, those which suffer more rapid adaptation to the stimulus.

In reducing a dislocated shoulder one would do well to give careful consideration to the known physiological functions of the proprioceptive system, and not to confine his attention entirely to the purely structural aspects of the condition.

SUMMARY AND CONCLUSION

A study of the literature reveals that many authors reject Kocher's method entirely, many more advise various "modifications", and a still larger number have offered new methods of reduction, most of them involving traction. Clinical, roentgenographic, and autopsy evidence does not support Kocher's beliefs as to the rôle played by the muscles, the capsule, and the greater tubercle of the humerus in dislocation of the shoulder. Kocher's method for reducing dislocation of the shoulder may well be omitted from the textbooks and more physiological methods substituted.

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TUBERCULOSIS OF THE SHAFT OF THE LARGE LONG BONES OF THE EXTREMITIES

BY C. K. HSIEH, M.D., LEO J. MILTNER, M.D., AND C. P. CHANG, M.D.,
PEIPING, CHINA

From the Department of Radiology and the Division of Orthopaedic Surgery, Department of Surgery, Peiping Union Medical College, Peiping, China

Tuberculosis of the shaft * of the large long bones of the extremities is reported by others as a lesion rare in Occidentals. Attention has not been called previously to its more frequent occurrence among the Chinese. During the past twelve years (1921–1932), thirty-eight patients with tuberculosis of the shaft of the long bones have been seen in this Hospital. These thirty-eight cases represent 4.8 per cent.† of a total of 786 cases of bone and joint tuberculosis treated during this time.

Because of insufficient data, twelve of the thirty-eight cases are not included in this report. Of the remaining twenty-six cases, twenty have been studied by the writers and form the basis of this paper. Six of the earlier cases have been described in a separate communication.‡

PATHOGENESIS

Various types of tuberculous involvement of the shaft of the long bones have been described, such as: (1) the periosteal form (Von Friedländer, Allison); (2) the solitary metaphyseal focus, a circumscribed low-grade lesion of the central portion of the bone, similar to the Brodie's abscess of pyogenic osteomyelitis (Von Friedländer, Zumsteeg, Sorrel and Sorrel-Déjerine, Lovett and Wolbach); and (3) the infiltrative lesion which may involve a portion, or even all, of the shaft of the bone (Koenig, Gralka and others). Most frequently, the infiltrative lesion includes from one-fourth to one-half of the length of the shaft. In rare instances, however, the entire shaft may be involved and may show multiple cystic areas scattered throughout the medullary and cortical bone, similar to the "Jüngling" type found in the "short" long bones (Van Alstyne and Gowen), or an osteitis with mixed sclerotic and rarefying lesions

* The term "shaft tuberculosis", as used by Hildebrandt, Zumsteeg, and Caan, includes lesions originating in the diaphysis and metaphysis and excludes lesions of the shaft of the bone which represent an extension of the disease from the epiphysis or from the joint. The writers prefer this definition and have included in their reports only those cases which come under this category.

† The relatively high percentage of this form of lesion among the Chinese is apparent when a comparison is made between this figure and figures from other clinics, which vary between 0.8 per cent. (Kuettner) and 0.9 per cent. (Zumsteeg). One of the writers (L. J. M.) found four cases in a total of 1,000 cases of bone and joint tuberculosis treated in Steindler's clinic (0.4 per cent.). According to Caan, the figures of Schiftan and Karewski (4 per cent.) and Scheimflug (11 per cent.) are probably incorrect, since these authors included in their statistics not only the primary processes of the shaft, but also those secondary to tuberculosis of the epiphysis.

‡ The article by Dr. G. W. VanGorder appeared in the April issue of this *Journal*. See Bibliography.

(Schinz) which are spread out in multiple foci over the shaft without involvement of the epiphyses and joints.

From the variety of these types, it is apparent that in most respects tuberculous lesions of the shaft may simulate the osteomyelitic lesions produced by pyogenic bacteria, and, therefore, it is believed that the mode of infection is the same in either condition. Koenig first emphasized the embolic theory of skeletal tuberculosis. He believed that tubercle bacilli, entering the bone by way of the blood stream, are stopped at a narrow or terminal portion of a capillary and that a tubercle results. In 1904, Lexer showed that the capillaries of the epiphyseal, metaphyseal, and diaphyseal blood vessels in young individuals do not anastomose, and, therefore, are end vessels. The finer ramifications of the blood vessels in each of these regions are directed toward the epiphyses, and this explains partially the usual location of the primary foci in tuberculous infections of the shaft. The actual point of localization is determined by the relationship between the size of the infecting embolus and the size of the blood vessel in which it becomes lodged.

The position of the embolus, or thrombus, with respect to the main nutrient vessel, the virulence of the bacilli, and the resistance of the local tissues are all factors which help to determine the nature of the lesion. The dominant characteristics of the pathological picture are: (1) thrombo-arteritis or thrombo-phlebitis; and (2) necrosis of the bone cells consequent to the disturbance of the circulation. According to Fraser, the extent of the lesion depends for the most part upon the second factor. If a tuberculous embolus becomes lodged, or if a thrombus forms in the nutrient artery before its division into primary branches, the thrombosis may spread widely throughout the entire intra-osseous vascular network and the disturbance of the blood supply for the given bone becomes maximum in degree. If infection spreads throughout the whole area of impaired circulation, necrosis of the entire diaphysis may follow. The periosteal circulation remains undisturbed except for a physiological dilatation of the blood vessels secondary to the underlying infection; therefore, the formation of involucrum is usually quite active. When thrombosis occurs in one of the primary branches of the nutrient vessel, the extent of the lesion depends upon the degree of intra-osseous clotting and infection, and upon the efficacy of the collateral circulation, especially that part which comes by way of the periosteal blood vessels. Following a spreading infection in this location, one-fourth, or even one-half, of the shaft may be involved. When the infected embolus is arrested in one of the terminal branches of the nutrient or metaphyseal arteries, only a small area of necrosis may follow. If the virulence of the organisms is low, the condition may persist as a circumscribed chronic bone abscess; on the other hand, if the virulence is high, the local lesion may extend directly to involve the medullary portions of the bone in the immediate neighborhood, or may spread into the epiphysis and finally reach the joint.

In excellent studies of the microscopic pathology of shaft tuberculosis, Fraser, Allison, and Lovett and Wolbach have each emphasized the facts that the tubercle bacillus can duplicate the reaction of almost any type of pathogenic bacterium, and that in tuberculosis of the bone, as in tuberculosis of the soft tissues, there may occur: (1) an exudate, fibrinous or puriform; (2) discrete proliferative tubercles, which may progress slowly or rapidly with much or little caseation: and (3) a diffuse proliferative reaction (tuberculous granulation tissue) with much or little caseation. These writers agree that, in most forms of shaft tuberculosis, the lesions are usually characterized by the destruction of bone, but that in certain instances there may be a marked tendency to the proliferation of bone. Allison states that "we should not lose sight of the fact that tuberculous lesions behave in a manner directed by the tissue reaction to infectious processes. When the tubercle bacillus invades tissues which in their reaction to infection readily produce new bone, the lesion observed has as one of its characteristics *new bone formation*." Consequently, when cancellous bone is involved, destruction predominates, and, when the periosteum is involved, proliferation takes place.

REPORT OF CASES

CASE 1. A Chinese woman, aged thirty-seven years, was admitted to the Hospital because of chronic pain, distributed irregularly over the entire body. Several days before admission, the pain became so severe that the patient was forced to stay in bed.

Entrance examination revealed the presence of generalized osteomalacia and minimal pulmonary tuberculosis (not active).

Roentgenograms showed that the pelvis was heart-shaped; there were also multiple fractures of the ribs and of the os pubis. There was a definite formation of new bone beneath the periosteum of the middle portion of the shaft of the right tibia on its anterior surface (Fig. 1). This lesion appeared not unlike syphilitic periostitis.

After complete metabolic studies had been made, the diagnosis of osteomalacia was confirmed. The blood contained a normal amount of calcium. There were, however, three milligrams of phosphorus per 100 cubic centimeters of blood,—slightly less than normal.

An exploratory operation was performed on the tibia. By means of an Albee saw, a piece of the periosteum, cortex, and the underlying medullary bone was removed from the involved area. Microscopic examination of sections of these tissues showed definite evidence of tuberculous infection of the periosteum and superficial layers of the cortex (osteitis) without involvement of the deeper layers of the cortex or of the medullary bone. The patient received the routine conservative treatment for osteomalacia and gradual improvement was noted. Within a short period of time, the generalized pain in the muscles disappeared and the fractures healed promptly.

Six months after the operation, follow-up roentgenograms of the right tibia showed no marked changes. There was no evidence of extension of the periostitis or of abscess formation. A slight swelling persisted over the involved region of the tibia.

Allison and Fisher believe that this type of tuberculosis forms a distinct clinical entity. These writers have described lesions that developed in dogs when the subperiosteal region of the long bones was infected with tubercle bacilli. These lesions remained limited to the subperiosteal region and did not extend into the deeper portions of the underlying cortex and cancellous bone.

FIG. 1

Roentgenogram of Case 1, showing the form of tuberculous lesion designated as Type I. Note the proliferation of periosteum in the middle third of the right tibia, most marked over the anterior cortex. The periosteal new bone is rarefied and irregular. The underlying cortex shows slight rarefaction. The roentgenographic diagnosis was syphilitic periostitis. This patient also had generalized osteomalacia.

FIG. 2

Roentgenogram of Case 11, showing another instance of a tuberculous lesion of the periosteal type. Note that this lesion is similar to the one shown in Fig. 1. There is dense periosteal new bone around the shaft of the left tibia at the junction of the middle and distal thirds, without rarefaction.

CASE 2. A Chinese male, aged twenty-one years, was admitted to the Hospital because of a painful swelling of six months' duration in the right lower forearm. One month after the onset the swelling ruptured and a discharge of pus was still present at the time of admission.

The general physical examination was essentially negative except for the surgical condition.

Roentgenograms showed a large oval-shaped abscess in the distal end of the diaphysis of the right radius, with rarefaction and thickening of the cortex and irregular proliferation of the periosteum involving the entire distal third of the shaft. There was marked absorption of the cortical bone.

An exploratory operation was performed. The bone was saucerized and a sequestrum was removed from the abscess. Since secondary infection was present, the wound was treated by Orr's method. Specimens of bone and soft tissue removed at the operation showed evidence of tuberculosis.

The infection of the bone became quiescent seven months after operation and at

that time the sinus had healed completely. In a follow-up letter, written one year later, the patient stated that his health was good and that there was no evidence of recurrence of the infection in the bone.

Case 3. A Chinese girl, aged seven years, gave a history of chronic pain and swelling of two years' duration in the left lower thigh.

Entrance examination showed essentially normal findings except for the surgical condition. There was a large swelling over the distal third of the shaft of the femur, extending to the left knee.

Roentgenograms showed extensive destruction of bone of the distal end of the shaft of the femur, and evidence also of an extension of the infection into the region of the epiphysis.

At exploratory operation, the abscess cavity in the bone was unroofed and packed loosely with gauze which had been impregnated with iodoform powder. The wound was closed partially with catgut sutures. Specimens of bone and soft tissue showed evidence of tuberculosis. The patient received postoperative treatment, consisting of rest in bed and immobilization of the affected extremity, despite which the infection extended into the knee joint.

Follow-up examination one year later showed that the tuberculous lesion of the femur was quiescent. There was no evidence of tuberculosis of the lungs or other viscera.

Case 4. A Chinese male, aged forty years, complained of pain and swelling of a year's duration over the upper portion of the right arm. Two months after the onset, the swelling was opened by a native physician, following which the wound drained continuously. A sinus was present at the time of admission.

Entrance examination revealed generalized lymphadenitis, chronic suppurative otitis media with mastoiditis, and ascariasis.

Roentgenograms showed irregular destruction of the proximal third of the shaft of the right humerus, with erosion of the cortex and proliferation of the periosteum. Because of the extension of secondary (pyogenic) infection into the right shoulder joint, the upper third of the shaft and the head of the right humerus were resected. Specimens of bone and soft tissue showed evidence of tuberculosis. The usual conservative treatment was used following the operation. Several weeks later, the patient's general condition was greatly improved and he was allowed to go home. The follow-up is incomplete.

Case 5. A Chinese woman, aged thirty-three years, was admitted to the Hospital because of recurrent hemoptysis, loss of weight, fever, and chronic swelling, with a discharging sinus over the upper portion of the left leg.

Physical and roentgenographic examinations showed evidence of active pulmonary tuberculosis involving both upper areas. Roentgenograms of the left leg showed a small central area of destruction in the proximal third of the shaft of the tibia.

The usual conservative treatment was instituted for the pulmonary condition, and, under spinal anaesthesia, an unroofing operation was performed on the lesion in the left tibia. A definite abscess containing cheesy material was found. Specimens of bone and soft tissue showed microscopic evidence of tuberculosis. Since the abscess was infected with pyogenic organisms, the Orr treatment was used.

Three months after operation, the wound of the tibia had healed, and there was no roentgenographic evidence of extension of the infection. At that time the patient's pulmonary condition was definitely improved. Reexamination, six months after operation, showed that the bone lesion was quiescent.

Case 6. A Chinese male, aged nineteen years, first noticed a painful swelling in the left lower forearm six months previous to admission. Four months after the onset, the swelling ruptured spontaneously, with a discharge of thin, yellow, purulent material.

Shortly after this, a painful swelling developed in the left axillary region and ruptured with a purulent discharge.

Entrance examination showed normal findings except for the condition of the bone and the axillary lymphadenitis which was thought to be tuberculous in nature.

Roentgenograms showed a definitely circumscribed central abscess in the distal third of the shaft of the radius. There was no evidence of infection in the distal epiphysis or in the wrist joint.

Shortly after admission, the sinus leading to the radius was excised, a sequestrum removed, and the abscess cavity saucerized. Since secondary infection was present, the wound was left wide open, vaselin gauze dressings were inserted, and a cast was applied according to the technique of Orr. Specimens of bone and soft tissue removed at the time of operation showed microscopic evidence of tuberculosis.

Approximately eight months after operation, the wound was healed and the patient noticed a gradual return of the function of the left wrist and hand. Two years after the operation a small painless swelling appeared in the region of the old operative scar. At that time, follow-up roentgenograms showed definite evidence of renewed activity of the lesion. Further surgical treatment was advised, but was refused by the patient.

Case 7. A Chinese girl, aged eleven years, came to the Hospital because of a painful swelling of one and one-half months' duration in the middle portion of the right leg. Two weeks prior to admission, the swelling had ruptured, with a discharge of pus.

The general physical and roentgenographic examinations at the time of admission showed evidence of active tuberculosis of the root of the lung and the adjacent pulmonary parenchyma; there was also an area of central destruction in the middle and distal thirds of the shaft of the right tibia, with rarefied thickening of the cortex and proliferation of the periosteum.

One week after admission, an unroofing operation was performed on the tibia, after which Orr's treatment was carried out. Specimens of bone and soft tissue removed from the diseased area showed microscopic evidence of tuberculosis. In spite of prolonged conservative treatment, the operative wound failed to heal.

Two and a half years after operation, a draining sinus was still present. Roentgenograms at that time showed an area of radiotransparency, which was larger than that seen in previous follow-up films. The edges of the diseased area of bone appeared hazy and irregular, suggestive of renewed activity. The pulmonary disease was still active. Further treatment was advised, but was refused by the patient.

Case 8. A Chinese girl, aged nineteen years, came to the Hospital because of a painful swelling over the upper third of the right leg. A bilateral pulmonary tuberculosis was present.

Roentgenographic examination also showed marked thickening of the cortex of the entire proximal third of the shaft of the right tibia distal to the level of the tuberosity. The thickened cortex was rarefied, and there was a moderate amount of proliferation of the periosteum which was distinct from the involved cortex.

The patient received the usual conservative treatment for the pulmonary lesion.

A short time after admission an exploratory operation was performed on the right tibia. Considerable caseous material was found beneath the periosteum and in the deeper portions of the lesion in the cancellous bone. Small sequestra were removed and the bone was saucerized. Microscopic examination of tissues removed at operation showed evidence of tuberculosis. The usual conservative treatment was given, but the patient grew worse steadily.

Approximately one year after operation, the pulmonary lesions had extended considerably and the local bone lesion showed slight extension. There is no further record.

Case 9. A Chinese male, aged thirty-two years, was admitted to the Hospital because of a painful swelling and a discharging sinus of two years' duration in the proximal third of the left leg.

Moderately active pulmonary tuberculosis, involving both upper lungs, was found.

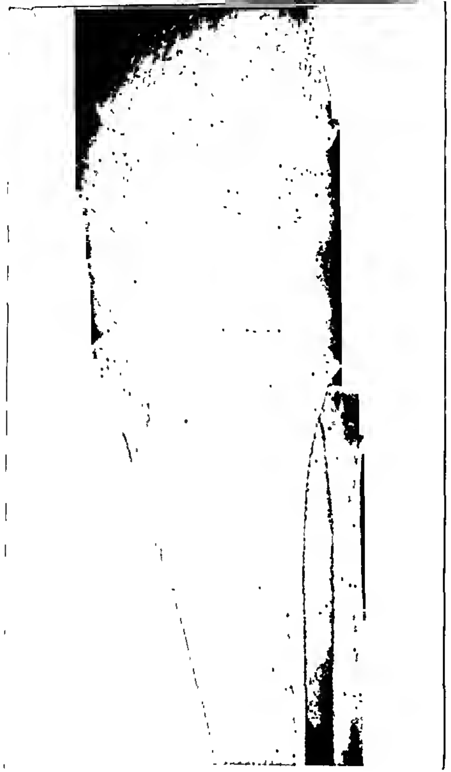

Fig. 3

Roentgenogram of Case 13, showing the form of lesion designated as Type II. A large oval cavity is located in the proximal cancellous portion of the tibia, two centimeters below the epiphyseal line. The area of destruction is well defined, except at its inferior lateral margin where the outline is indistinct. A small sequestrum is present in the cavity. The surrounding zone shows moderate con-

Fig. 4

Lateral view of the same case shown in Fig. 3. The abscess cavity is less distinct, but the condensation of the anterior cortex is more evident. Minute scattered areas of erosion of the cortex may be seen.

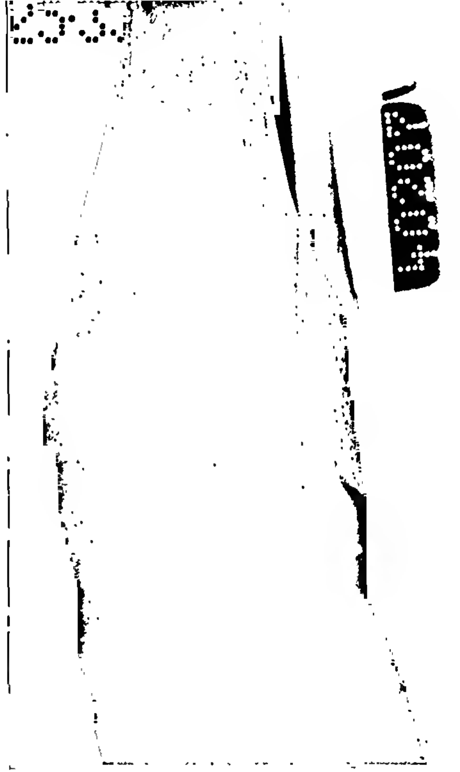

Fig. 5

Roentgenogram of Case 20, showing another tuberculous lesion belonging to Type II. Note the large, localized area of destruction with several sequestra in the distal portion of the tibia. The medial cortex is included in the abscess. There are diffuse condensation and scattered small areas of erosion in the surrounding bone. The distal articular surface of the bone is intact.

There was a localized abscess cavity in the upper third of the shaft of the left tibia just below the tubercle.

Conservative treatment for the pulmonary tuberculosis was instituted and, under spinal anaesthesia, an unroofing operation was performed on the affected bone. The cavity contained caseous material and also several small sequestra. As much as possible of the diseased bone and soft tissue was excised. Microscopic examination of these tissues showed evidence of tuberculosis.

One year later, follow-up examination revealed a very small discharging sinus in the region of the old operative scar. Roentgenograms showed that the lesion in the bone had become quiescent. The function of the knee joint was quite satisfactory. The condition of the lungs had improved.

Case 10. A Chinese boy, aged five years, was admitted to the Hospital because of pain and swelling of thirteen months' duration in the right lower leg. Eleven months prior to admission, the swelling ruptured, with a discharge of purulent material. Two months later, another sinus developed near by. On admission both sinuses showed a discharge of purulent material.

Physical and roentgenographic examinations showed essentially normal findings except for the lesion of the tibia. There was a circumscribed abscess of the bone (similar to the Brodie's variety) about two centimeters above the epiphyseal line. There was a slight extension into the epiphysis.

An unroofing operation was performed and definite evidence of tuberculosis was seen in the bone and soft tissue which was removed. The wound had healed completely four months later.

On examination two years later, the patient was found to be in good health and the tuberculous infection of the bone was quiescent.

Case 11. A Chinese woman, aged twenty-seven years, came to the Hospital because of painful swellings with draining sinuses over the right forearm and left leg. Both of these swellings had been present for approximately one year previous to admission. The patient's general health was poor.

Physical and roentgenographic examinations revealed moderately advanced pulmonary tuberculosis of the upper areas of both lungs. Roentgenograms showed a thickening of the cortex and periosteum in the mid-portion of the shaft of the left tibia. In the distal fourth of the shaft of the right ulna, there was a definite area of destruction of the cortex and medulla for a distance of about two and five-tenths centimeters.

At operation, the distal fourth of the shaft of the ulna was resected entirely, and the diseased soft tissue was excised. Postoperative treatment according to Orr's method was carried out. Specimens of bone and soft tissue removed at the operation proved to be tuberculous. There was no biopsy of the tibial lesion, but, on the basis of the presence of an active pulmonary tuberculosis and the positive microscopic diagnosis of tuberculosis of the ulna, the tibial changes also were considered to be of the same nature.

Three months later, the pulmonary and bony lesions showed no improvement. Further treatment was not accepted by the patient.

Case 12. A Chinese boy, aged five years, gave a history of pain and swelling of two months' duration in the upper portion of the left arm. The swelling gradually increased in size until it ruptured, with a discharge of pus, two weeks before admission to the Hospital.

The general physical examination presented essentially normal findings except for the condition of the bone.

Roentgenograms showed a small circumscribed abscess in the central portion of the proximal third of the shaft of the left ulna, two centimeters distal to the joint surface of the coronoid process. The roentgenographic appearance was that of a bone abscess of the Brodie type.

This cavity was curetted and the bone was saucerized. Since a draining sinus was present, the wound was left wide open, packed with vaselin gauze, and treated according

FIG. 6

Roentgenogram of Case 6, showing the form of tuberculous lesion designated as Type III. The distal third of the radius is destroyed, with abscess formation and sequestration. The adjacent cortex shows condensation and thickening throughout approximately one-half of the shaft. In the thickened cortex there are many minute areas of erosion. Dense periosteal bone may be seen on the ulnar side of the lesion.

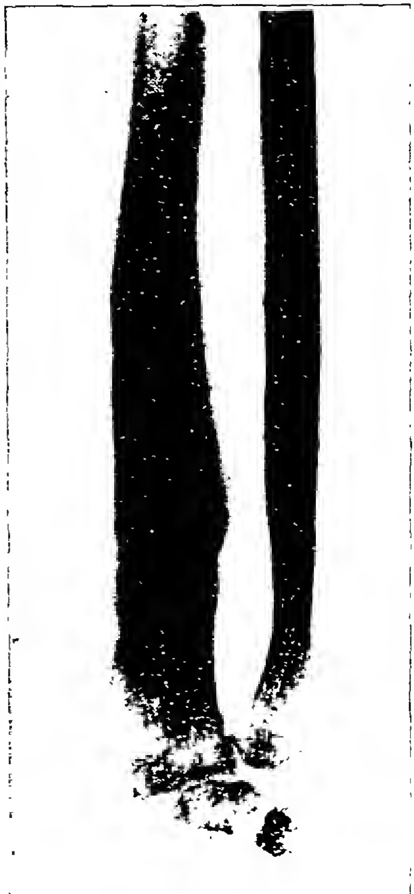

FIG. 7

Roentgenogram of the same case shown in Fig. 6, taken thirteen months later and eight months after operation, showing healing of the diseased area.

to Orr's method. Microscopic examination of the bone revealed the presence of tuberculosis. The wound of the bone and soft tissue healed in approximately three months.

The patient was seen eighteen months after the operation. At that time the lesion of the bone was healed and evidence of tuberculosis in other parts of the body was not found.

CASE 13. A Chinese girl, aged six years, was admitted to the Hospital because of a discharging sinus of one year's duration over the upper third of the left leg.

General physical and laboratory examinations showed essentially normal findings except for the surgical condition.

Roentgenograms showed an oval-shaped area of destruction of the proximal third of the shaft of the left tibia, two centimeters below the epiphyseal line. There was slight condensation of the bone surrounding the abscess.

The bone was saucerized and treated according to Orr's method. Microscopic examination of tissues removed at operation showed evidence of tuberculosis. The

wound failed to heal. Consequently, a second operation was performed one and one-half years later, at which time the bone again was saucerized and parts of the diseased soft tissue were resected.

Eight months after the second operation the wound healed and the lesion in the bone appeared quiescent. There was no extension of the infection into the epiphysis or into the knee joint. The general condition of the patient was excellent. The function of the knee was good.

CASE 14. A Chinese girl, aged nineteen years, first noticed a painful swelling of the right forearm nine months prior to admission. Three months after the onset, the swelling ruptured and discharged thin, yellow pus. A sinus was present at the time of admission. The general physical examination was essentially negative except for the condition of the bone.

Roentgenograms showed a well defined walled-off abscess of the bone in the distal third of the shaft of the right radius.

At operation, the old sinus tract was followed down to the bone; the bone was curetted, and a sequestrum and some caseous material were removed from the cavity. The cavity was swabbed with iodine and alcohol, and Orr's principles of postoperative treatment were followed. Microscopic examination of the bone and soft tissue removed from the diseased area showed evidence of tuberculosis. The patient received the usual conservative treatment.

In a follow-up letter, two years later, the patient stated that a discharging sinus was still present in the lower forearm. The patient's general health was excellent.

CASE 15. A Chinese male, aged twenty-two years, was admitted to the Hospital for the treatment of tuberculous cervical lymphadenitis and osteomyelitis of the left ulna.

The general physical and laboratory examinations showed essentially normal findings except for the conditions named.

Roentgenograms showed a large area of rarefaction of the central portion of the proximal third of the shaft of the left ulna, with condensation of the surrounding bone.

The operative treatment consisted of resection of the diseased soft tissue, saucerization of the bone, and immobilization according to the Orr method. Microscopic examination of specimens of bone and soft tissue showed evidence of tuberculosis.

Seven months after operation, the wound over the left ulna had healed completely, and the patient's general condition was excellent. The tuberculous infection of the cervical lymph glands remained quiescent.

CASE 16. A Chinese girl, aged eight years, complained of a chronic, painful swelling of six months' duration over the upper portion of the right leg. Three months prior to admission, the swelling ruptured, with a discharge of thin, yellow pus. The discharge continued until the time of admission. Two weeks prior to admission, the patient began to notice pain in the lumbar region.

Roentgenographic examination showed a central destructive lesion in the upper third of the shaft of the right tibia. In the proximal end of the shaft of the left tibia, there was an area of rarefaction which extended through the epiphyseal line and involved the epiphysis. Later examination showed destruction of the body of the fifth lumbar vertebra.

The lesion of the right tibia was explored. The bone in the area of the abscess was saucerized and the cavity was curetted. Specimens of bone and soft tissue taken from the diseased area proved to be tuberculous. The patient received conservative treatment at home.

Eight months later, in a follow-up letter, the parents stated that paralysis of the leg and bladder had developed. Hospital treatment was advised, but was refused.

CASE 17. A Chinese girl, aged fifteen years, gave a history of the insidious onset (nine months previous to admission) of pain and swelling in the upper portion of the

right forearm. About one month before admission, the swelling ruptured, with a discharge of pus.

Roentgenograms showed a circumscribed chronic bone abscess in the proximal end of the shaft of the right ulna.

The operative treatment consisted of saucerization and curettage of the bone. Specimens of bone and soft tissue removed at the operation showed microscopic evidence of tuberculosis. The usual conservative treatment was carried out.

In a follow-up letter, received ten months after operation, the patient stated that the wound continued to discharge a small amount of yellow, purulent material. At that time, the patient did not have any symptoms of pulmonary or visceral tuberculosis.

Case 18. A Chinese male, aged twenty-one years. complained of a painful swelling with a discharging sinus of three months' duration over the left second metacarpal region, and a painful swelling with a discharging sinus of one month's duration over the lower third of the right fibula.

General physical and roentgenographic examinations revealed essentially normal findings except for the condition of the bones. There was rarefaction and destruction of the entire thickness of the cortex of the left second metacarpal bone (spina ventosa), and also of the distal third of the shaft of the right fibula. There was no evidence of extension of the lesion into the ankle joint. In the fibula there was marked lace-like formation of new hone in the periosteum of the involved area.

Evidence of tuberculosis was found in the granulation tissue which was curetted from the draining sinuses. Surgical treatment of the tuberculous osteomyelitis was advised, but was refused by the patient.

Case 19. A Chinese girl, aged sixteen years, stated that, eight months previous to admission to the Hospital, a painful swelling had developed gradually in the lower portion of the right forearm. Four months after the onset, the swelling ruptured, with a discharge of thin, yellow pus. Seven months prior to admission, the patient noticed slight pain and swelling of the left knee joint.

Physical and roentgenographic examinations showed a localized area of destruction of bone in the distal third of the shaft of the right radius. The wrist joint was not involved.

An operation was performed on the right radius, during which the bone was saucerized and the diseased soft tissue was resected. Because of extensive secondary infection, Orr's treatment was used.

Approximately one year after the operation, the infection of the bone and soft tissue of the right radius appeared quiescent.

Because of persistence of pain and swelling in the left knee, an exploratory operation was performed on that joint. Microscopic examination of the synovial tissues of the knee showed tuberculosis. Consequently, an arthrodesis was performed. Four months after the operation, the bones of the knee joint had fused solidly. The patient received the usual conservative treatment.

Seven months after the second operation, the patient's general condition was good. Both tuberculous lesions (radius and knee) appeared quiescent.

Case 20. A Chinese male, aged twenty-one years, was admitted to the Hospital because of chronic swellings and draining sinuses over the lower portion of the left leg, right fifth metacarpal bone, and right elbow joint.

General physical and roentgenographic examinations showed normal findings except for the lesions in the bones. Specimens of granulation tissue curetted from the sinuses showed microscopic evidence of tuberculosis. Roentgenograms demonstrated extensive tuberculous lesions in the regions of the right elbow. the right fifth metacarpal bone, and the lower third of the shaft of the left tibia. There were several draining sinuses just above the left internal malleolus. There was definite tuberculous involvement of the synovia of the ankle joint.

The right arm was amputated several days after admission. Four weeks later. the lesion in the shaft of the tibia was saucerized and. in addition, an arthrodesis was performed on the ankle joint.

TABLE I

TABULATION OF CASES

Case	Age and Sex	Location of Lesion	Type of Lesion *	Tuberculosis Proved (Microscope)	Associated Tuberculosis	Operative Treatment	Results
1	37 F	Tibia, middle third.	I	Yes	None	Bone saucerized.	Good. Six months after operation, lesion of bone appeared quiescent. No sinus.
2	21 M	Radius, distal third.	III	Yes	None	Bone saucerized. Partial ostectomy.	Good. Wound healed one year after operation. Function of right hand good. No sinus.
3	7 F	Femur, lower third.	III	Yes	None	Bone saucerized.	Good. Lesion quiescent after one year. No drainage.
4	40 M	Humerus, upper third.	III	Yes	Extension into shoulder joint and axilla.	Resection of upper end of humerus; Orr's treatment.	Poor. Unimproved. Incomplete follow-up. Sinuses present.
5	33 F	Tibia, upper third.	III	Yes	Pulmonary tuberculosis, moderately advanced.	Bone saucerized.	Fair. Bone lesion quiescent six months after operation. No drainage.
6	19 M	Radius, distal third.	III	Yes	Suppurative tuberculosis of axillary glands.	Bone saucerized; Orr's treatment.	Poor. Bone lesion unhealed two years after operation. Abscess present.
7	11 F	Tibia, middle and distal thirds.	III	Yes	Pulmonary tuberculosis, minimal, active.	Bone saucerized.	Poor. Pulmonary condition improved. Bone lesion active. Two years later, discharging sinus still present over bone lesion.
8	19 F	Tibia, upper third.	III	Yes	Pulmonary tuberculosis, moderately advanced.	Bone saucerized.	Poor. Pulmonary tuberculosis and bone lesion growing progressively worse one year later.
9	32 M	Tibia, upper third.	III	Yes	Pulmonary tuberculosis, moderately advanced.	Bone saucerized.	Fair. Bone lesion relatively quiescent one year after operation. Sinus present.
10	5 M	Tibia, lower third.	II	Yes	None	Two saucerization operations.	Good. Lesion quiescent four months after operation. Examination two years later showed healed lesion.

11	27 F	Tibia, middle third. Ulna, distal fourth.	I II	Yes	Pulmonary tuberculosis, moderately advanced.	Resection of distal end of ulna.	Fair. Pulmonary condition stationary. Diseased area of bone excised. Three months after operation, wound healed and pulmonary condition improved. No further follow-up.
12	5 M	Ulna, proximal third.	II	Yes	None	Bone saucerized.	Good. Wound healed three months later. Apparent cure at follow-up one and one-half years later.
13	6 F	Tibia, upper third.	II	Yes	None	Two ostectomies.	Good. Eight months later, after second operation, wound healed. Bone lesion quiescent. No discharge.
14	19 F	Radius, lower third.	II	Yes	None	Bone saucerized.	Good. Lesion active, with a draining sinus still present two years after operation.
15	22 M	Ulna, upper half.	II	Yes	None	Bone saucerized; Orr's treatment.	Good. Lesion quiescent after seven months. Function of elbow good.
16	8 F	Tibia, right, upper third.	II	Yes	Fifth lumbar vertebra; left tibia.	Partial ostectomy of right tibia.	Poor. Both bone lesions very active eight months later.
17	15 F	Ulna, upper third.	II	Yes	None	Resection of ulna.	Fair. Ten months after operation, bone lesion relatively quiescent. Small sinus present.
18	21 M	Fibula, lower third.	III	Yes	Metacarpal region.	Refused treatment.	
19	16 F	Radius, distal third.	II	Yes	Knee joint.	Bone saucerized. Arthrodesis of knee.	Good. Lesion of radius quiescent after seven months. No sinus. Solid union of knee after four months.
20	21 M	Tibia, lower third.	II	Yes	Ulna (elbow joint); metacarpal bone.	Partial ostectomy of tibia. Amputation of arm.	Fair. At follow-up three months later, lesion becoming quiescent.

* Type of Lesion:
I—Tuberculous Periostitis
II—Solitary Tuberculous Abscess (Brodie's Type)
III—Localized Tuberculous Osteomyelitis
IV—Massive Tuberculous Osteomyelitis (See Figs. 10 and 11)

Three months after the second operation, the patient's general condition was very satisfactory. There was beginning fusion of the ankle joint. The wound over the shaft of the tibia continued to show a small amount of discharge. The patient is still in the Hospital.

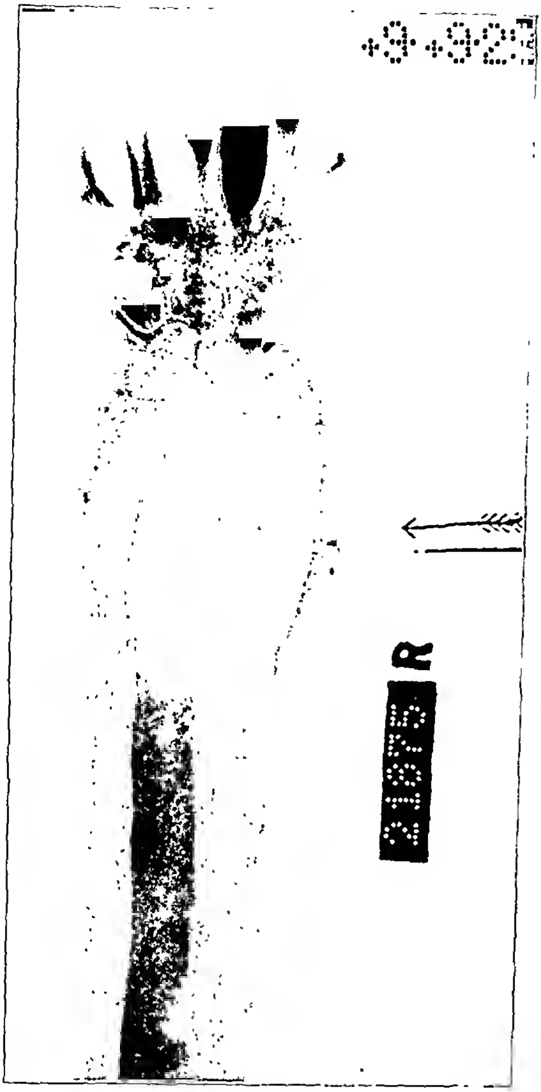

FIG. 8

Roentgenogram of Case 2 (Type III). An oval-shaped area of destruction, with a sequestrum, is seen in the distal end of the diaphysis of the radius. The cortex is thickened, laminated, rarefied, and eroded irregularly. The periosteum shows irregular proliferation. The serrated edges of the periosteal bone are often seen in cases with mixed pyogenic infection.

CLINICAL AND ROENTGENOGRAPHIC FINDINGS

In the group of cases under consideration, the symptoms differed in severity according to the virulence of the infection and the extent of the lesion in the bone. In the cases which showed the most extensive lesions (massive tuberculous infiltration of the entire shaft), the onset was subacute and was characterized by severe pain and swelling of the involved section of the limb. The pain and tenderness was marked during the first two weeks, after which time fluctuant swellings were noted in the soft tissues. The temperature of the patients varied from 37.2 degrees centigrade to 38.5 degrees. This form of tuberculous osteomyelitis * might easily have been mistaken for acute pyogenic infection of the bone.

Most of the cases, however, were of the less virulent form, and the infection was limited to a smaller portion of the shaft. In these cases, the infection was characterized by an insidious onset and a chronic course. Pain of a dull, aching character and muscle spasm were present for several days or weeks, following which soft-tissue swellings developed gradually. During this time, most of the patients showed a slight febrile reaction, accompanied by general malaise and a slight loss of weight. Usually the abscesses were not of the "cold" type, such as the gravitation abscesses of tuberculosis of the spine. In the cases of shaft tuberculosis, the abscesses formed directly

* Cases with a similar type of onset have been described by Reichel, Von Friedländer, Zumsteeg, Gralka, and others. In Gralka's cases, the onset of pain and disability was acute; the patient showed a temperature of 37.6 degrees centigrade and examination of the blood showed a white-cell count of 17,000.

over the diseased areas of the bone, and, since there was a great increase of the local blood supply, the skin over the abscesses was often hot and red, and the areas were tender on palpation. After several weeks, the abscesses tended to rupture spontaneously. This form of tuberculous infection of the shaft of the long bones differed from pyogenic osteomyelitis in that, as a rule, the onset was less acute, the pain was less severe, the febrile reaction was less pronounced, and the leukocyte count of the blood did not show a great increase in the number of polymorphonuclear cells.

In cases showing a circumscribed tuberculous abscess, the symptoms were similar to those of the Brodie's abscess of pyogenic osteomyelitis. As a rule, the onset was insidious and there were no constitutional symptoms. The patients complained of occasional attacks of dull, aching pain in the region of the lesion. Usually, pain was the only complaint during the first two or three months. Later on, however, the tuberculous abscesses showed a tendency to extend slowly through the cortex of the bone, eventually forming sinus tracts leading to the surface.

FIG. 9

Roentgenogram of Case 7 (Type III). The middle and distal thirds of the tibia present a large, poorly defined area of destruction. The cortex is thickened markedly, condensed irregularly, and rarefied (striated) with minute areas of erosion. The periosteal new bone is similarly involved.

In those cases showing tuberculous involvement of the periosteum, there were symptoms of mild, chronic pain and tenderness over the area of the lesion. There were no constitutional symptoms which could be ascribed to the local lesion.

Since the pathological and the clinical pictures of shaft tuberculosis are often similar to those found in pyogenic osteomyelitis, it is to be expected that errors will be made in the differentiation of these conditions.

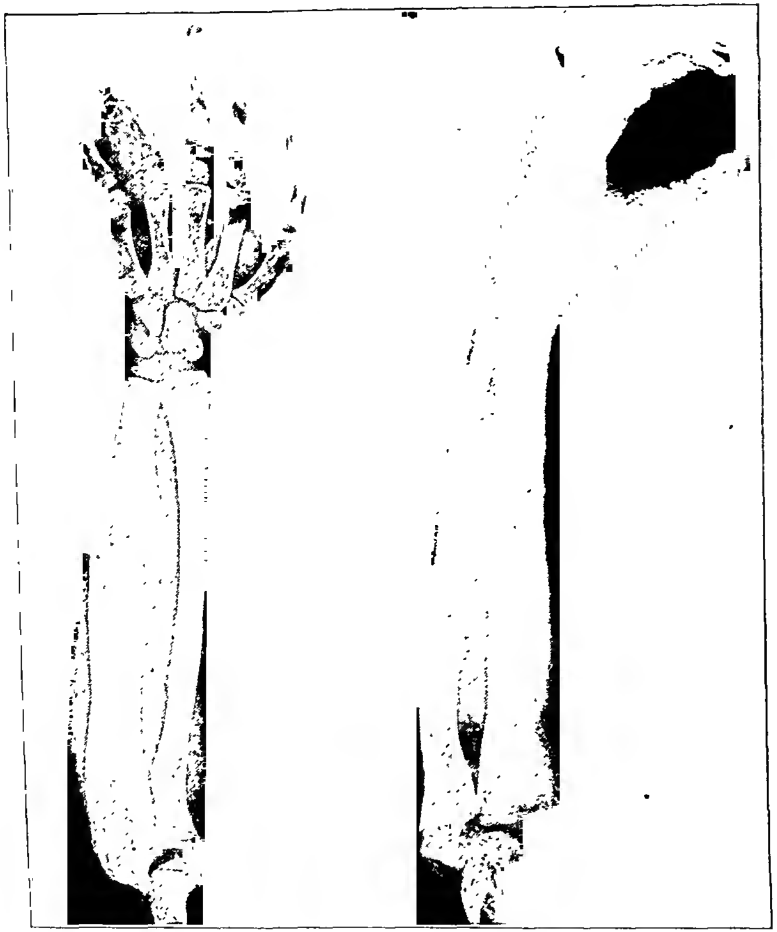

Fig. 10

Roentgenogram showing the form of tuberculous lesion designated as Type IV. Note the massive involvement of the entire shaft of the ulna. Two large abscesses are present, one in the proximal portion and the other at the junction of the middle and distal thirds. The cortex is markedly thickened, rarefied, and striated. The elbow and wrist joints are not involved. (Dr. G. W. VanGorder's case.)

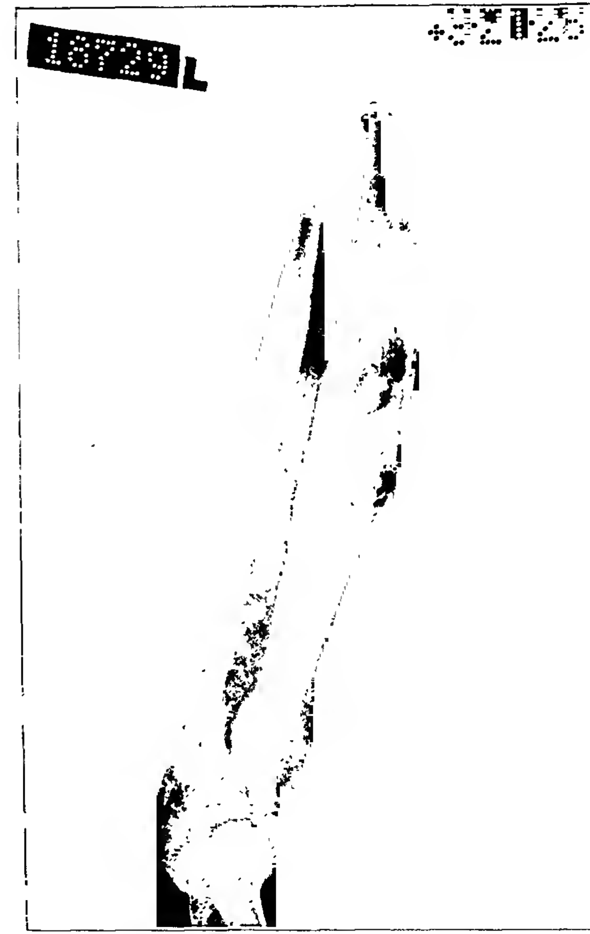

Fig. 11

Roentgenogram showing another instance of a lesion classified as Type IV. There are large abscesses, with sequestra, in the middle and distal thirds of the shaft of the radius. The cortex of the entire diaphysis shows rarefied thickening with multiple small areas of destruction. (Dr. G. W. VanGorder's case.)

However, in our study, we found certain changes in the roentgenograms which suggested the diagnosis of tuberculosis. When the periosteum was involved, the newly formed bone appeared to be rarefied irregularly and striated longitudinally. When the cortex was involved, it showed a thickening which was usually of the rarefying type, with a laminated appearance. In this rarefied, thickened cortex, or periosteal new bone, there were single or multiple areas of erosion or destruction. These destructive lesions were often very small and, therefore, careful examination was required for their detection. It should be emphasized that destruction of bone was considered the most important diagnostic finding even in those cases where proliferation predominated. In rare instances, the thickened cortex, or periosteal new bone, was condensed and sclerosed, with no areas of rarefaction or erosion. In such cases, the diagnosis of sclerosing osteomyelitis or syphilis was usually made. In the entire series of cases of tuberculosis of the shaft of long bones, a correct roentgenographic diagnosis was made in eleven instances. In four other instances, tuberculosis of the shaft was diagnosed largely on the strength of the characteristic, active, tuberculous lesions in the lungs and other bones. Taken together, a correct diagnosis was made in fifteen out of the twenty cases. A diagnosis of syphilis of bone was made in two cases and of chronic osteomyelitis in three cases. We attribute the comparatively high percentage of correct diagnoses largely to the fact that tuberculosis is very prevalent in North China, and, therefore, is always considered even in unusual locations.

We have divided the lesions into four types according to the roentgenographic appearance. This division is based largely on the location and extent of the lesions (see Table I).

Type I—Tuberculous Periostitis: This is the rarest form of shaft tuberculosis. It is characterized by rarefied, laminated, new bone in the periosteum over an apparently intact cortex (Figs. 1 and 2).

Type II—Solitary Tuberculous Abscess (*Brodie's Type*): This form is represented by a single area of destruction, usually located centrally in or near the metaphysis. The abscess may or may not be well circumscribed. In the early stages, there is relatively little condensation around its periphery, but, in the later stages, it is usually surrounded by fairly dense bone. Sometimes sequestra are present. Late in the course of the disease, the destructive process may involve the surrounding portion of the bone by direct extension, and then it becomes impossible to distinguish this type (Figs. 3, 4, and 5) from Type III.

Type III—Localized Tuberculous Osteomyelitis: In this form, a larger portion of the shaft is involved. Early in the disease, the medullary and cortical portions of the bone appear hazy and decalcified, with scattered rarefied areas of destruction. After many months, the destroyed areas of the medullary region show sharper lines of demarcation, and the cortex shows irregular areas of destruction and condensation. When the superficial layers of the cortex and the periosteum are involved, there

is usually a certain amount of involucrum present, which, although less in amount and less dense and homogeneous, may be very similar to that found in pyogenic osteomyelitis. Later in the disease, after sinuses have developed externally, the roentgenographic findings are frequently very confusing, because of the added factor of secondary infection which usually stimulates the formation of involucrum. In cases with mixed infection, the periosteal new bone often presents a very irregular outer surface, with fringy, serrated, or radiating projections of involucrum (Figs. 6, 7, 8, and 9).

Type IV—Massive Tuberculous Osteomyelitis: During the early stages of this lesion, roentgenograms show marked decalcification of the shaft, usually with a fusiform swelling of the periosteum and surrounding soft tissues. As a rule, in this type the circulation of the periosteum is not seriously affected, and, therefore, laminated layers of involucrum may be seen after several weeks or months. At this time, the cortical and medullary bone of the shaft shows extensive decalcification, with many scattered areas of destruction (Figs. 10 and 11).

COMMENT

In spite of the possibilities of making a correct diagnosis of shaft tuberculosis by clinical and roentgenographic signs, we have encouraged the use of an exploratory operation and microscopic diagnosis in every case, so that from the start we might be guided correctly in the treatment of the local condition. Also, because of the unreliability of physical findings in early pulmonary tuberculosis, we have secured roentgenograms of the lungs in every case of tuberculosis of the bone. With this help, we have been able to prescribe at an earlier date correct management of the patient's general condition.

The patients with shaft tuberculosis and active pulmonary lesions did not usually respond favorably to treatment. In these cases, the treatment of the pulmonary condition was considered of primary importance, and the lesions of the bone were treated by the usual measures. It is believed that amputation of an extremity may be strongly indicated in these cases, especially since complete eradication of an active peripheral focus may allow a greater chance for control of the visceral lesions.

Approximately seventy-five per cent. of the uncomplicated cases of shaft tuberculosis (those without associated tuberculous lesions) responded favorably, following the usual orthopaedic care. The operative treatment of the closed lesions (those without sinuses) consisted of unroofing of the diseased area of the bone and, whenever feasible, excision of as much as possible of the diseased bone and soft tissue. The defect in the bone was left unfilled, the wound was closed, and a plaster-of-Paris cast was applied.

The open cases (those with draining sinuses and accompanying secondary infection) were treated in much the same manner as the ordinary case of pyogenic osteomyelitis. However, in addition to the usual pro-

cedure, as much of the infected bone was excised as was possible without causing an interruption of its continuity. Wide excision of the tuberculous soft tissue was also carried out. Following the unroofing and excision procedure, the wound was packed with vaselin gauze and a cast applied according to the technique of Orr. In our hands, the Orr method has proved very satisfactory.

In many of our cases, secondary infection seemed to have a favorable influence upon the healing of tuberculous lesions of the shaft. We believe these observations to be correct, and explain them on the basis of an increased fibroblastic reaction of the soft tissues, as a result of which the tubercles become walled off and quiescent.

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EXPERIMENTAL MUSCULAR ATROPHY*

BY T. C. THOMPSON, M.D., OXFORD, ENGLAND
Resident Surgeon, Wingfield Morris Orthopaedic Hospital, Headington, Oxford

Because of the great variation in the extent of muscular atrophy resulting from simple immobilization as found by different workers[1,2], a series of experiments upon normal rabbits was undertaken to determine whether or not the extent of this atrophy could be limited by allowing weight-bearing.

One hind limb was immobilized for a period varying from one to six weeks, and the amount of atrophy determined by comparing the weights of the muscles of that limb with the weights of the corresponding ones of the opposite side. To determine what constituted a significant variation, the weights of the corresponding muscle groups from the two sides of untreated animals were compared.

EXPERIMENTAL METHODS

Controls

In a series consisting of ten normal rabbits and two rabbits with miliary tuberculosis, several groups of muscles were dissected out and compared with the same muscle groups in the opposite leg.

A standard method of removing and separating the different muscle groups, similar to that described by Beryl Harding [1], was used. The gastrocnemius and soleus, from their origins to their common insertion into the os calcis, were dissected out as one group. The quadriceps femoris, gluteus medius, and gluteus minimus formed a second group. The gluteus maximus, the hamstring muscles, and the adductors of the thigh were dissected out as a third group, leaving the other muscles of the hip intact. These three groups will be called: (1) Calf, (2) Thigh, (3) Ham.

Immediately after the animals were killed, the muscle groups were dissected out exactly and weighed at once. It was not considered necessary or desirable to desiccate the muscles before weighing them, as advocated by Lippmann and Selig [2].

EFFECT OF IMMOBILIZATION

Group 1. Weight-Bearing Allowed

Plaster-of-Paris spica casts were applied to a group of rabbits with the right hind limb flexed in a natural position, thus allowing weight-bearing but preventing motion (Fig. 1).

* From the Sir William Dunn School of Pathology, Oxford.

Group 2. Non-Weight-Bearing

Fig. 1
Flexed or weight-bearing position.

Another group of rabbits were put into plaster-of-Paris spicas with the right hind limb fully extended, so that weight-bearing was impossible (Fig. 2).

One rabbit from each group was killed at the end of each week for six consecutive weeks; the muscles were dissected out and their weights compared as in the control group. Microscopic sections of the muscles were made, and the bones were weighed and roentgenographed.

GENERAL OBSERVATIONS

In applying plaster to rabbits some difficulty was encountered. Plaster could be applied without padding of any kind and the circulation of the foot would remain good for several days. However, after three to seven days, the foot would become swollen and this oedema would only slowly subside after the plaster had been bivalved. For this reason cotton-wool padding was applied, especially around the knee, and any animal showing oedema of the foot at any time was discarded. No matter how great care was used in applying the plaster, and although there were absolutely no circulatory changes in the foot nor abrasions on the leg, there was always slight oedema to be seen in the muscles about the knee, if they were removed within a few hours after the removal of the plaster from the animal. Because of this, each rabbit was allowed forty-eight hours of freedom from plaster before it was killed and the muscles were removed.

Fig. 2
Extended or non-weight-bearing position.

All animals were quite active in plaster and remained in good condition except for a slight loss in weight. After the plaster was removed,

they gradually began to use the leg which had been immobilized. Those in which the leg had been in the weight-bearing position seemed almost normal within a few hours, while those which had had the leg in the extended position did not recover full use of it during the forty-eight hours that they were allowed free.

RESULTS

Gross Anatomy

The muscles of the immobilized leg showed definite changes, depending upon the length of time that the animal had been in plaster. There was often slight oedema of the tissues about the tendo achillis. After the first week or two the muscles were found to be flabby, moist, and pale. The red muscles had lost their color and become indistinguishable from the white ones. After six weeks' immobilization the changes were very striking, especially in those animals in which weight-bearing had not been allowed. The skin and subcutaneous tissue were not so freely movable as in the normal leg. The muscles were not compact groups of firm fibers, but were soft masses of pale oedematous material with considerable areolar and fibrous tissue scattered through them. They were inelastic and not easily divided into groups.

The bones showed no gross differences and no definite changes in the roentgenograms. The bones of the immobilized leg usually weighed less than those of the other leg, but the difference was not enough to be significant.

Loss of Weight

The variation in weight in the different muscle groups of the control animals is shown in Table I. The differences between the muscles of the two legs in normal animals are very small. The average variation is 1.9

TABLE I

WEIGHTS OF NORMAL RABBIT MUSCLES

Animal No.	Weight in Grams	Calf		Thigh		Ham		Total	
		Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
A	1830	13.1	12.9	43.1	43.3	63.5	62.5	119.8	118.7
992	1900	11.8	11.8	41.4	38.6	66.0	67.8	119.2	118.2
991	1361	8.3	8.4	27.2	28.2	38.2	36.7	73.7	73.3
1052	2023	15.5	15.5	44.0	42.6	69.8	67.0	129.3	125.1
1056	2345	17.0	17.5	62.5	62.5	79.0	79.2	158.5	159.2
1057	2165	16.3	16.0	47.0	46.0	66.1	67.9	129.4	129.9
1058	2230	16.5	16.5	47.4	48.6	66.5	66.5	130.4	131.6
1059	1975	14.2	14.1	44.1	43.7	64.5	65.7	122.8	123.5
a	2985	18.1	17.6	66.8	64.6	95.6	94.4	180.5	176.6
b	2660	17.6	16.8	64.5	64.4	98.9	96.4	181.0	177.6
c	2743	17.5	17.2	62.2	62.1	94.6	97.4	174.3	176.7
d	2330	14.0	14.2	53.2	53.4	78.2	78.1	145.4	145.7

TABLE II
WEIGHTS OF MUSCLE GROUPS
WEIGHT-BEARING POSITION

Animal No.	Time in Plaster	Weight in Grams	Loss of Weight	Calf		Thigh		Ham		Total	
				Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
1106	1 week	2776	61*	17.4	16.6	65.8	69.0	85.0	86.0	168.2	171.6
1133	2 weeks	2630	150	14.9	16.6	52.0	55.3	77.9	79.2	144.8	151.1
1105	3 weeks	2725	275	15.9	17.6	61.0	64.0	90.0	93.3	166.9	174.9
1103	4 weeks	3230	200	24.4	24.8	82.1	82.5	107.9	119.9	214.4	227.2
1134	5 weeks	2100	35	11.6	14.2	49.2	48.8	66.5	63.8	127.3	126.8
1104	6 weeks	2553	73	12.5	18.0	53.8	56.6	65.4	72.8	131.7	147.4

* Gain.

per cent. of the muscle weight, and the only marked discrepancy is seen in Rabbit 992 in which the thigh muscles of the left leg weighed 2.8 grams less than those of the right. This rabbit had miliary tuberculosis and was generally underweight.

The atrophy in the three muscle groups in the immobilized animals is shown in Tables II and III. It is roughly proportional to the time of immobilization and definitely greater in those animals in the non-weight-bearing position. A few results seem inconsistent, but they are generally quite uniform. Rabbit 1134, after five weeks in the flexed position, showed atrophy in the calf and slight increase in weight in the other groups. This animal was allowed three days out of plaster before being killed and was unusually active. In this position the immobilization is best in the calf muscles and in them the atrophy is most marked. Rabbit 1101, after four weeks in the extended position, showed no atrophy in the thigh muscles. This was probably due to the fact that he was killed twenty-four hours after the plaster was removed and there was still slight oedema above the knee.

The total atrophy of the three muscle groups is shown in Figure 3. The

TABLE III
WEIGHTS OF MUSCLE GROUPS
NON-WEIGHT-BEARING POSITION

Animal No.	Time in Plaster	Weight in Grams	Loss of Weight	Calf		Thigh		Ham		Total	
				Right	*Left*	*Right*	*Left*	*Right*	*Left*	*Right*	*Left*
1132	1 week	2515	338	15.3	19.0	55.0	56.7	81.6	85.0	151.9	160.7
1138	2 weeks	2590	110	13.4	16.8	47.5	57.4	73.2	77.5	134.1	151.7
1100	3 weeks	2205	95	11.0	14.4	40.5	51.2	58.0	66.1	109.5	131.7
1101	4 weeks	2424	376	10.0	15.2	46.8	46.8	56.0	72.3	112.8	134.3
1125	5 weeks	1715	158	5.9	10.3	27.0	36.9	37.9	47.6	70.8	94.8
1099	6 weeks	2056	475	9.1	16.3	42.8	54.5	54.6	72.5	106.5	143.3

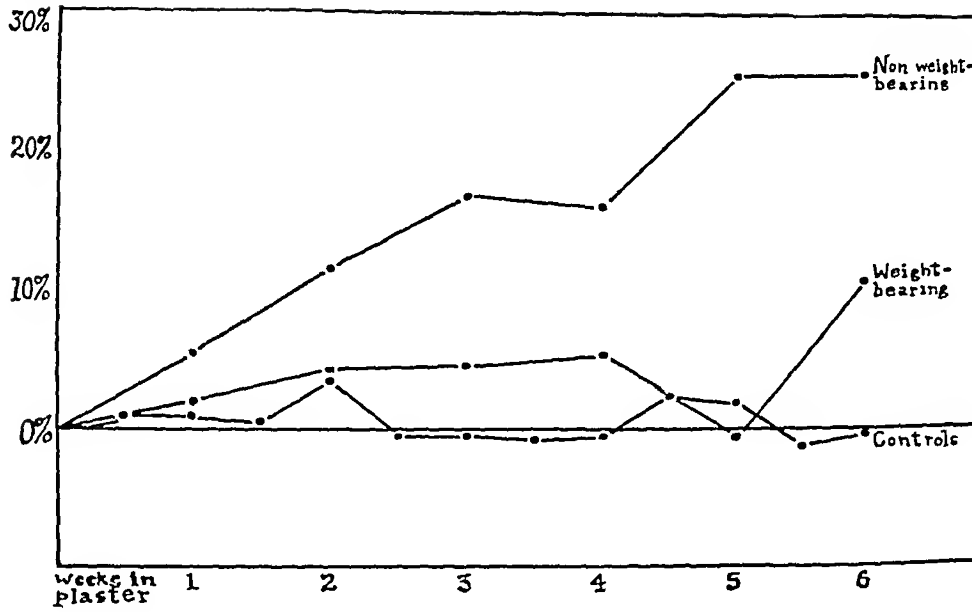

Fig. 3
Total atrophy in three groups of muscles.

loss in weight is shown in percentages of the weight of the normal muscles. The atrophy of the calf muscles is shown in Figure 4. In this group of muscles, which were most completely immobilized, the atrophy was very

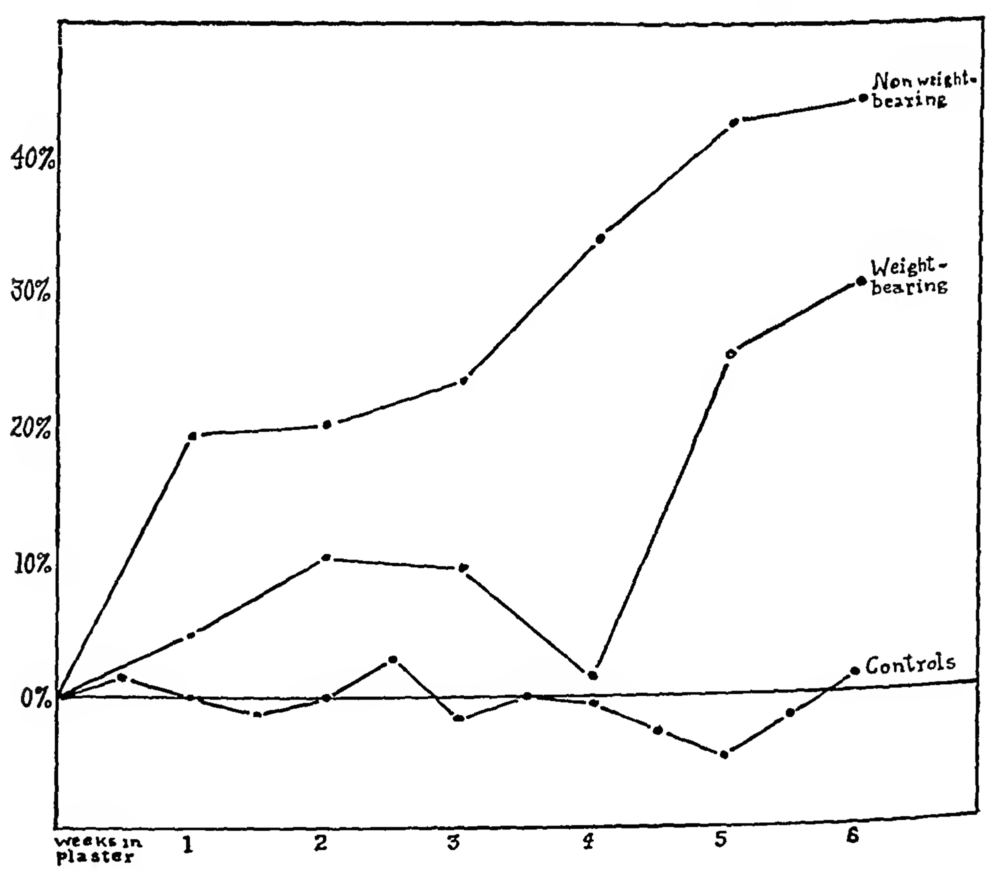

Fig. 4
Atrophy of calf muscles.

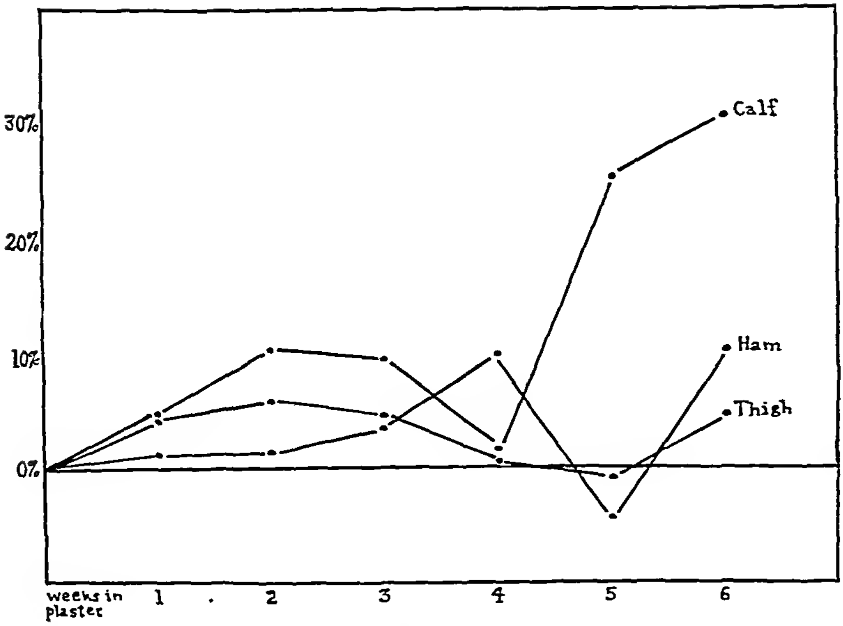

FIG. 5-A

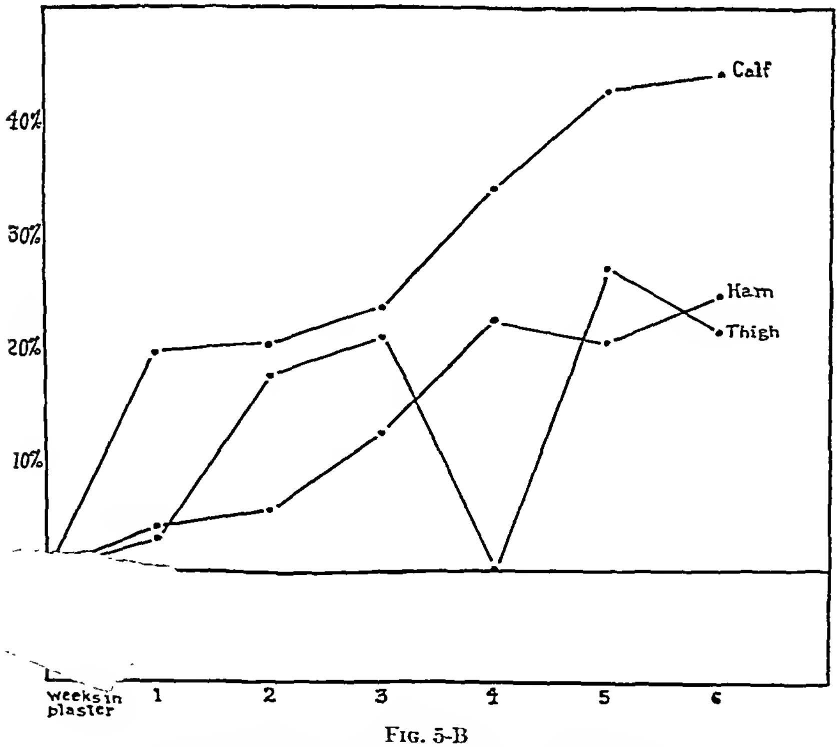

FIG. 5-B

Comparison of atrophy of calf, ham, and thigh muscles.
FIG. 5-A. Weight-bearing. FIG. 5-B. Non-weight-bearing.

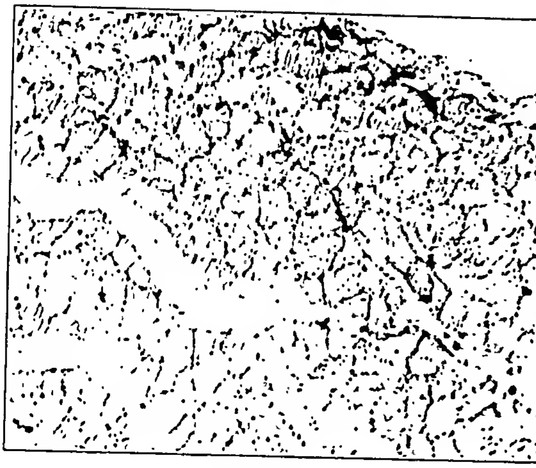

FIG. 6

(1125L) Cross section of normal rabbit muscle, showing mixed red and white fibers.

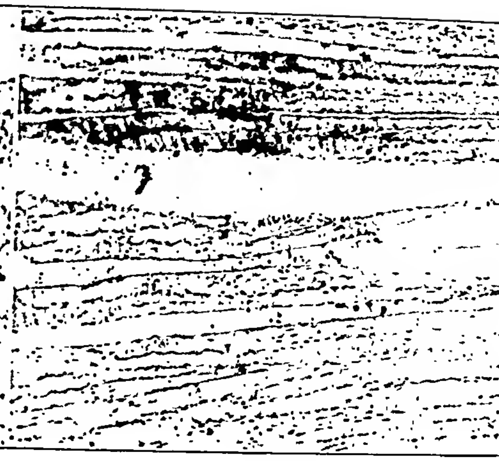

FIG. 9

(1131L) Longitudinal section of normal rabbit muscle.

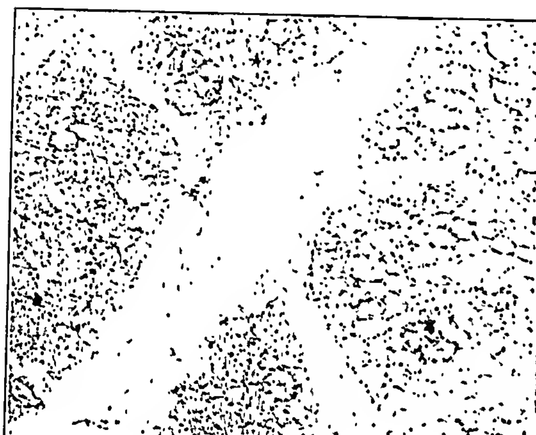

FIG. 7

(1125R) Cross section of muscle after five weeks' immobilization. The fibers stain equally and are pale. The average size of the fibers is less.

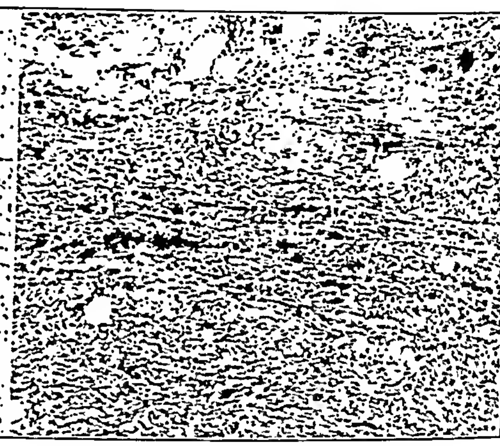

FIG. 10

(1125R) Longitudinal section of rabbit muscle after five weeks' immobilization, showing extensive fibrosis with faintly stained, poorly outlined muscle fibers.

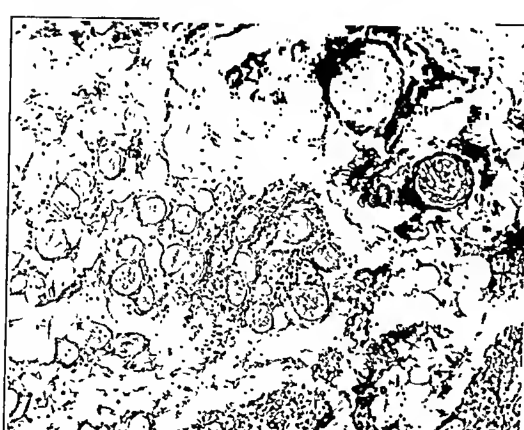

FIG. 8

(1099R) Cross section of part of a muscle after six weeks' immobilization, showing muscle fibers scattered through areolar tissue.

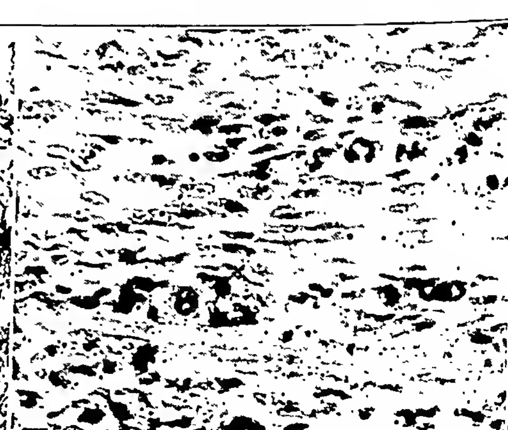

FIG. 11

(1125R) High-power photomicrograph of same muscle.

extensive, amounting to forty-four per cent. of the normal weight in one instance.

In Figures 5-A and 5-B the atrophy in the three different muscle groups is compared. These charts show the atrophy to be considerably greater in the calf muscles than in the other two groups in both the weight-bearing and non-weight-bearing animals.

Microscopic Changes

No attempt was made to make a detailed study of the histological changes as atrophy progressed, but the gross changes were so striking that a few sections were made, some of which are reproduced in Figures 6–11. The greater number of sections showed pale, evenly stained fibers, and of slightly smaller average size in animals which had been immobilized five or six weeks than those in the normal muscle. There were scattered areas of comparatively normal muscle, while a few muscle fibers were found scattered through loose areolar tissue and not grouped together into bundles. A few areas showed marked fibrosis through which were scattered a few pale, poorly outlined, apparently degenerating muscle fibers.

DISCUSSION

The atrophy of disuse is rapid and extensive; but it can be limited greatly by allowing weight-bearing. This fact can be of practical value in the regulation of treatment leading to the reduction of the period of immobilization, and allowing normal function in the form of weight-bearing at the earliest possible moment. Further studies are desirable, in order to determine whether or not a muscle, which has lost thirty to forty per cent. of its weight and shows definite histological changes, can completely regain its previous weight and normal structure.

CONCLUSIONS

1. Extensive muscular atrophy can be produced in rabbits by immobilization in plaster.
2. The extent of this atrophy can be considerably lessened by permitting weight-bearing.
3. Under the conditions of these experiments the calf muscles showed more atrophy than the thigh or hamstring muscles.

The author wishes to thank Prof. Dreyer for the privilege of working at the Sir William Dunn Pathology Laboratory and the staff for their cooperation and assistance.

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MAGGOT THERAPY

Technique and Clinical Application *

BY ARCHIE FINE, M.D., AND HOWARD ALEXANDER,
NEW ORLEANS, LOUISIANA

Since the publication of Baer's reports [1, 2, 3] on the therapeutic use of fly larvae in various surgical conditions, many articles [4, 5, 6, 7, 8] have appeared, in all of which this type of therapy is recommended as a valuable adjunct to the surgeon's armamentarium. It is admitted that the difficulties encountered limit its use to large institutions in which the services of an entomologist are available. Briefly, these difficulties are as follows: (1) the securing of a suitable variety of fly; (2) the constant production of large quantities of eggs; (3) the sterilization of eggs; and (4) a satisfactory means of confining the maggots in the wound. During the past six months, we have conducted experiments designed to overcome these difficulties. Our results have been so uniformly successful, and the cost of production so low, that we feel justified in reporting our experience.

SOURCE OF LAYING STOCK

Our original laying stock was obtained by exposing fresh meat in the open near a meat market. The meat, with the accompanying eggs, was placed in a pint jar and the top covered tightly with a piece of sheeting. Unfortunately, liquefaction of the meat resulted in the drowning of the maggots. Further experimentation led us to discover that, if support was offered the maggots in the form of cotton or gauze half filling the jar, they were able to continue their growth. We learned later that Nettrour had made a similar observation [9]. The maggots, thus aided, grew to maturity and pupated in the gauze, the entire period occupying seven days.

The pupae were shaken out and tied in little gauze bags for convenience in handling. They were placed in a covered jar and allowed to hatch, the period required for hatching occupying from five to seven days.

Many varieties of flies hatched out. They included specimens of the blue-black blow fly (*Formia regina*), the gray flesh fly (*Sarcophaga hemorrhoidalis*), the bright green blow fly (*Lucilia sericata*), the Texas screwworm fly (*Chrysomyia macellaria*), and a dull, copper-colored, greenish-tinged blow fly (*Lucilia cuprina*)†.

The flies were separated according to species by the following method, and placed in separate cages. After they had hatched in the jars, they were sprayed with ether through the sheeting by means of an atomizer, and the top of the jar was more securely covered with a Petri dish. After

* From the Departments of Pathology of the Medical Center of the Louisiana State University and of the Charity Hospital, New Orleans, Louisiana.

† Our identification of this species was confirmed by Aldrich of the National Museum, Washington.

a few minutes, the unconscious flies were emptied into a Petri dish and examined. With a little practice, it is possible to identify a large number of species in a short time. After examination, the flies were placed in the laying cages to revive. Those which were too immature to have identifying markings were replaced in the jar. Apparently, the ether had no ill effects, as very few flies failed to revive, and there was no impairment of laying ability. We still use this method of examination of flies in order to prevent contamination of our laying stock.

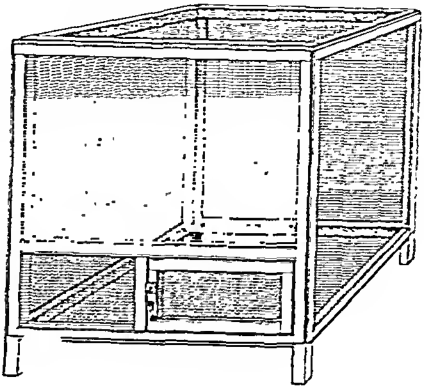

FIG. 1
Drawing of improved fly cage.

In order to compare the laying ability of the flies, approximately the same number were placed in each cage. The cages used were similar to those described by Murdoch and Smart [10]. We found that the *Lucilia cuprina,* which is mentioned by Fabre in his classic essay, "The Green Bottles", was the most prolific, and this is the fly which we use in our work (Fig. 2, *B*). Many writers report that their flies begin to lay within five to six days after hatching. *Lucilia cuprina* begins to lay within ninety-six hours after hatching. Whether this is characteristic of the species, or whether our climate is responsible, we do not know, but probably the former explanation is correct, as most workers use *Lucilia sericata.*

RECOGNITION OF THE TEXAS SCREW-WORM FLY

The ability to recognize the Texas screw-worm fly, which is found throughout the United States and southern Canada during the summer months, is of so much importance that the species warrants a detailed description. It resembles the *Lucilia sericata,* or green bottle fly, which is the variety most commonly used in maggot therapy. Morgan [11], in his detailed study of the Texas screw-worm fly, describes it as follows: "When the fly emerges, it is grey, but soon assumes its permanent color which is a bright, metallic green. Just behind the head (thorax) there are three distinct black stripes running from the head to the abdomen. The eyes are of a dull red color, and quite prominent. The wings are long, and in many instances lap one over the other on the body, presenting a narrowed appearance. The whole fly is a little larger than the ordinary house fly (*Musca domestica*)."

The larvae of the Texas screw-worm fly attack living tissue, boring their way through, and causing excruciating pain. Cattle die from infestation with larvae of this fly, and several cases of death in man have been reported. That this fly has contaminated fly broods is suggested by the experience of Buchman and Blair [12] who reported that one batch of their

maggots bored large cavities in healthy granulation tissue, actually increasing the size of the wound and causing considerable pain. Unfortunately, the entomologist to whom these flies were submitted was not able to identify the species (Fig. 2, *A*).

REARING OF FLIES

We have abandoned the use of the small cages in favor of a new cage, thirty by thirty by thirty inches, covered with copper screening, and capable of housing about 2,000 flies (Fig. 1).

The food consists of pieces of orange, sugar cubes, and lean meat. Recently a mixture of equal quantities of whole egg and orange juice has been added. This is poured on gauze placed in a Petri dish. The eggs are collected every four hours, at which time a fresh supply of meat is placed in the cage. We have found that a continuously fresh supply of meat increases the fecundity of the flies.

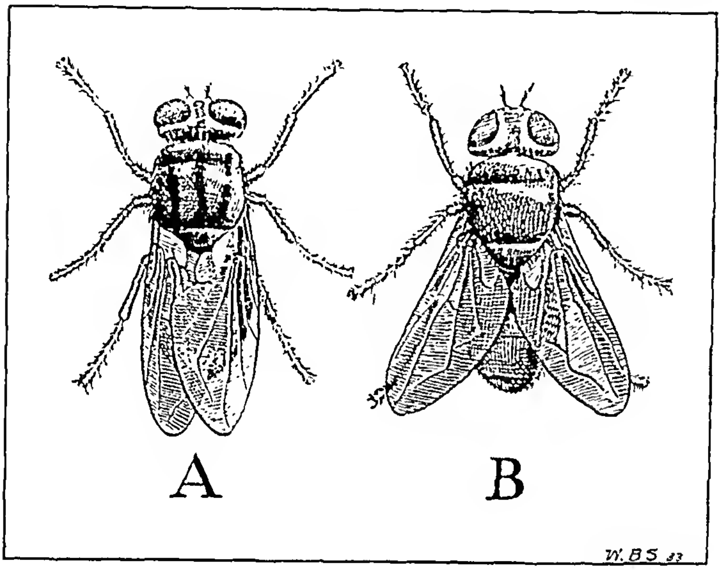

FIG. 2

A. Drawing of Texas screw-worm fly (*Chrysomyia macellaria*).
B. Drawing of *Lucilia cuprina*.

During the winter, the flies are kept in a steam-heated room, the temperature of which is maintained at about seventy degrees Fahrenheit. No attention is paid to the question of humidity or ventilation. The flies thrive, and their laying ability is not affected.

STERILIZATION OF EGGS

The eggs are collected every four hours. They are picked off the meat with a toothpick, placed on damp filter paper, and stored in the icebox. The sterilization process is as follows:

Separation of the Eggs: Various methods are in use; some workers shake the clumps of eggs vigorously in a test tube of saline solution; others wash them in Dakin's solution containing one per cent. sodium carbonate. We have obtained satisfactory results by rolling the clumps of eggs against the side of a test tube half filled with a 0.85 per cent. solution of sodium chloride, using a cotton-tipped applicator. The eggs, thus separated, sink to the bottom of the tube. The importance of the complete separation of eggs cannot be overemphasized. We attribute most of our failures in sterilization to incomplete separation of eggs.

Sterilization Apparatus (Fig. 3): The component parts are as follows:

1. A gallon jug, *A*, containing a ten per cent. solution of formalin, as first used by Child and Roberts [13], and later by Weil, Nettrour, and Sweadner [14]; a two-holed rubber stopper into which is inserted a glass funnel, filled with sterile absorbent cotton and covered with gauze, and rubber and glass tubing, connected with the sterilizing chamber, *C*.

2. A gallon jug, *B*, containing 0.85 per cent. sodium chloride solution, connected with the sterilizing chamber, *C*.

3. Sterilizing chamber *C*, consisting of: (*1*) a piece of glass tubing six inches by seven-eighths of an inch (a large culture tube with its lower end cut away may be used); (*2*) three rubber stoppers; (*3*) a funnel filled with absorbent cotton and covered with gauze; (*4*) miscellaneous pieces of glass and one-eighth inch rubber tubing. The chamber is closed at the top with a two-holed rubber stopper. In the stopper is inserted the glass funnel and glass tubing which is connected with the jug containing the sterilizing solution, *A*. In the middle of the chamber is a rubber stopper (Fig. 3, *C-2*), which has been reamed out so that its walls are about three millimeters thick. A string is fastened to the stopper by means of a small strip of wood. The top of the stopper is covered with close-meshed gauze, upon which the eggs collect. The bottom of the chamber is closed with a one-holed stopper (Fig. 3, *C-3*), through which projects a piece of glass tubing. *B* and *C* are sterilized separately.

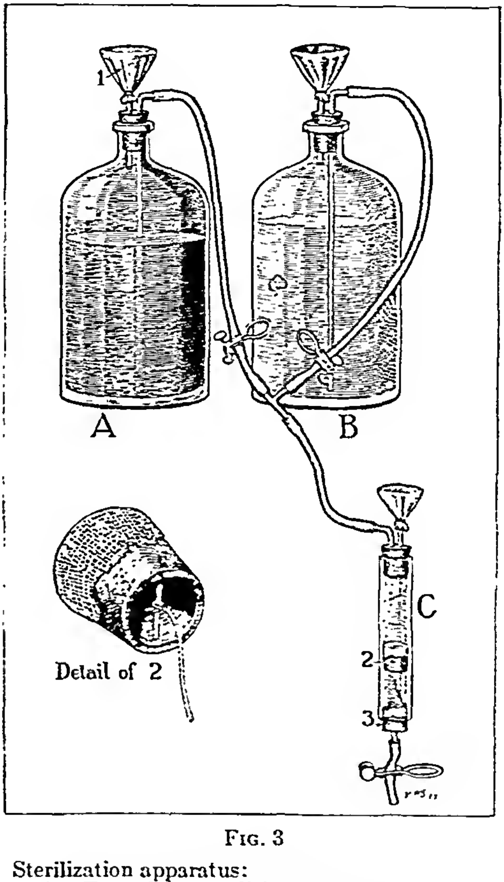

FIG. 3

Sterilization apparatus:
A. Formalin—sterilizing solution.
B. Sodium chloride solution—washing fluid.
C. Sterilization chamber.

The advantage of this sterilization set-up is that no air can come in contact with the fluid or the eggs without first being filtered, thus reducing the risk of contamination to a minimum.

Technique: The top stopper of the sterilizing chamber is removed, and the eggs are poured in. The sodium chloride solution runs out through

the bottom of the chamber, and the eggs are caught on the gauze covering the middle stopper. Formalin is run in slowly until it fills the entire chamber. It is then run in and out several times in order to agitate the eggs. After a five-minute period, the formalin is run out and a 0.85 per cent. solution of sodium chloride is run in. The formalin is colored with methylene blue merely to indicate when the eggs are free of formalin in the washing process. Any eggs that may be caught on the sides of the chamber are washed down by tilting the chamber so that the entering stream of washing solution plays directly upon them. After the washing process is completed, the stopper is removed and the lip of the tube is flamed. The middle stopper is pulled down by the attached string, the lip of the tube is again flamed, and the middle stopper is pulled out. The gauze, with the eggs attached, is transferred aseptically to a four-ounce specimen bottle (Fig. 4).*

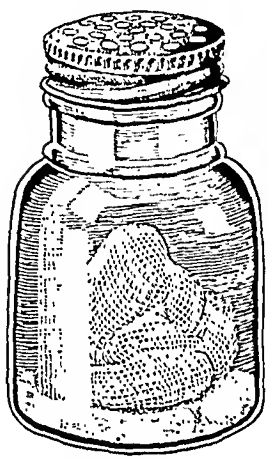

Fig. 4
Specimen bottle, containing sterile whole egg.

The entire process of sterilization is completed by one person in approximately eight minutes. The volume of eggs sterilized at one time is about one cubic centimeter. It has been found that one-tenth of a cubic centimeter contains approximately 500 eggs.

CULTIVATION OF STERILE MAGGOTS

The eggs are incubated at thirty-seven degrees centigrade in order to permit any bacteria which may be present ample opportunity to grow. Each specimen bottle contains ten cubic centimeters of a mixture of equal parts of whole egg and 0.85 per cent. sodium chloride solution which has been placed in a bath of boiling water to allow the egg to coagulate. The egg is then broken up. A small piece of gauze, soaked in 0.85 per cent. sodium chloride solution, is placed in the specimen bottle which is closed with a perforated metal screw cap packed with cotton. The bottle is then sterilized. Contrary to the observation of Buchman and Blair [12] that maggots will not live on autoclaved egg, we have found that sterile maggots liquefy the egg only if the surface has been broken up. The bottles are placed in a glass jar containing water-soaked gauze to keep the air moist.

We are able to control the growth of the maggots by limiting the quantity of media to a definite amount for a definite quantity of eggs. When the maggots are from two to three millimeters in length, they are ready for use. They are tested for sterility from twenty-four to thirty-six hours after hatching. Several maggots are transferred to the following media: one per cent. dextrose blood agar, one per cent. dextrose brain broth, and meat mash covered with vaselin. The maggots are kept in the

* In order to minimize the risk of contamination during the sterilization process, we wrap the lower quarter of the chamber in paper, which is removed when the eggs are taken out.

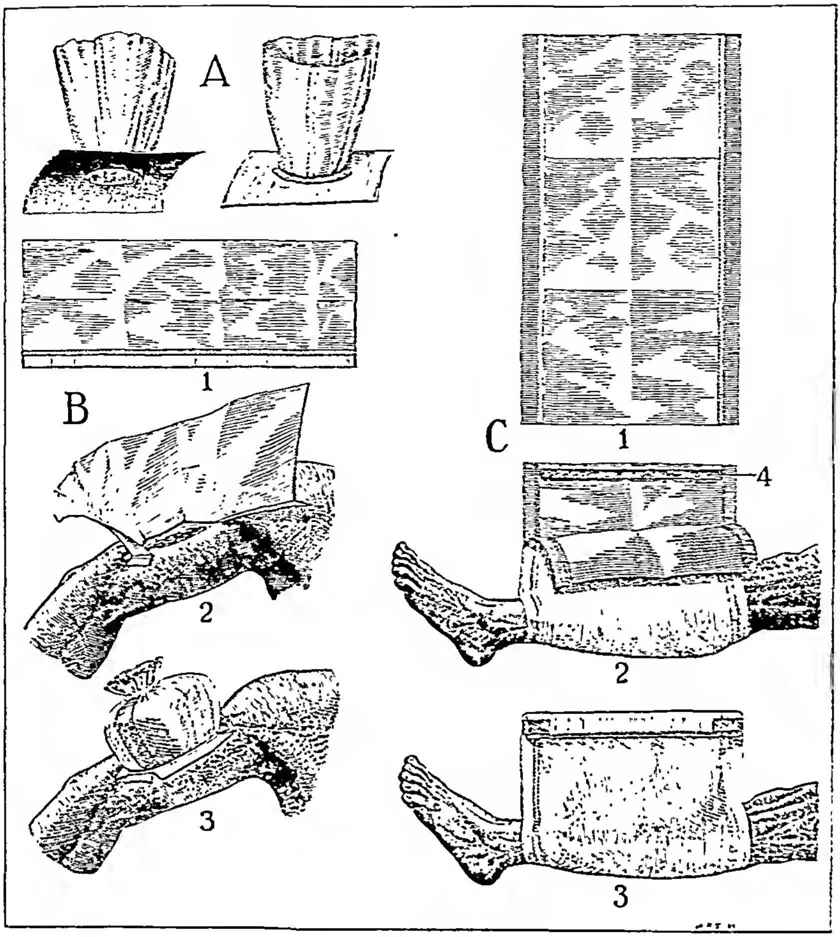

FIG. 5
Drawing of three types of maggot cages.

ice-box and, if growth is observed within forty-eight hours, this particular batch of maggots is discarded.* We have also noticed that, if a specimen bottle has an odor, the batch of maggots which it contains is invariably non-sterile.

By the use of the sterilization technique just described, more than eighty per cent. of the maggots are rendered sterile.

METHOD OF APPLICATION OF MAGGOTS TO WOUNDS

We use three types of cages. Type *A* (Fig. 5) has been used in cases of osteitis of the jaw and other small wounds. It consists of a sheet of adhesive tape in which is cut an opening slightly larger than the wound. A sleeve from six to eight inches long, made from ordinary sheeting, is

* As an added precaution, antitetanic serum is routinely administered to patients undergoing treatment.

sewed to the adhesive tape around the margin of the opening. Figure 6 shows the cage in place.

Type *B* (Fig. 5) consists of a piece of sheeting, ten inches wide, to which is sewed a narrow strip of adhesive tape (*B-1*). *B-2* and *B-3* show the method of applying the cage. Type *B* may be used for almost any wound.

Type *C*, which is used for very extensive wounds of the limbs, consists of a piece of sheeting, to which is sewed two strips of adhesive tape. The cage is closed by rolling the free end on a stick (*C-4*), or by tying it.

We found that it was very difficult to remove the sizing after the cage had been autoclaved. We have overcome this difficulty in the following manner: the sizing is removed; some crinoline gauze is placed loosely over the bare adhesive tape; and then the cage is autoclaved.

The edges of the wound are cleaned with ether and alcohol. We have found that the cage adheres better if some ordinary rubber cement is spread on the skin according to the directions on the tube.

The cage is applied and a thin layer of gauze is placed over the wound. The maggots are removed from the specimen bottle by picking up the gauze with sterile forceps and wiping it around the sides. This mops up most of the maggots. If any are left, fresh gauze is placed in the bottle and the procedure repeated. A large quantity of gauze is now placed on top of the maggots to absorb the exudate which later forms. The cage is closed by tying it at the top (*B-3*). All cages are reinforced with adhesive tape. We have found it necessary to replace the exudate-soaked gauze at intervals of about twenty-four hours, and at this time, if it seems necessary, the cage is further reinforced with adhesive tape.

We have found all three types of cages to be very satisfactory. The maggots rarely escape. The cage has been left in place for as long as ten days, fresh maggots being applied when necessary. Occasionally, we have permitted ambulatory patients to go home with the cage in place.

Many workers stress the necessity of light and air for the well-being of the maggots. Our experience has convinced us that mortality among the maggots is due to drowning in exudate rather than to lack of light or air. As a matter of fact, we have rarely found any dead maggots in a wound.

ACTION OF MAGGOTS IN THE WOUND

The maggots have no difficulty in penetrating the gauze in order to reach the wound. In one of our experiments, freshly hatched maggots penetrated a thickness of five inches of dry, closely packed gauze in order to reach their food. When they are full grown, they leave the wound and enter the gauze for the purpose of pupating. They are then removed with the waste gauze which has become soaked with exudate.

Our cages permit inspection of the maggots at work in the wound, and some interesting observations have been made. In the case of an

abscess of soft tissue, which we had opened by making a small stab wound, the maggots spread the opening apart by wedging themselves into it. The entire cavity was filled with maggots, with only the tails showing. Now and again, one would back out and another would take its place. At the end of twenty-four to forty-eight hours, the activity of the maggots is greatest, and the wound looks clean. At the end of seventy-two hours, exudate has accumulated, as the maggots have ceased to feed. At this time, fresh maggots may be placed in the cage.

The action of the maggots is twofold: (1) they perform a rapid and thorough débridement when used in sufficient numbers; (2) they stimulate the formation of granulation tissue. It has been noted that, after débridement has been accomplished, a slight amount of bleeding occurs, and, at this time, the patient's discomfort reaches the maximum. The maggots require more than forty-eight hours to reach full size. In soft-tissue infections, two or three applications are sufficient for complete débridement; in osteomyelitis many more applications are necessary. When débridement is complete, fewer maggots are used, and their function at this time is to keep the wound clean and to promote healing. Maggots do not digest dead bone, but in our opinion they definitely hasten sequestration.

FIG. 6

Case 4. Photograph showing Type A cage in place in the treatment of osteitis of the jaw.

No difficulty is experienced in removing the maggots from the wound, because, when they are fully grown, they burrow into the gauze. Washing the wound with sodium chloride solution is, therefore, unnecessary, and if, as Livingston and Prince [15] have reported, an active principle is liberated by the maggots, it is thus preserved. During the time when the maggots are active in the wound, the patient's temperature frequently rises from two to four degrees. This we attribute to the absorption of liquefied necrotic tissue. Pitting oedema around the wound is sometimes seen during the first day or two, but subsides on the third or fourth day.

RENEWAL OF LAYING STOCK

At the beginning of our work, we obtained additional flies by growing maggots in jars containing meat, as previously described. This method has since been discarded as it is space-consuming and the odor is objectionable.

The gauze and maggots which are removed from the wound are

collected in paper bags and placed in a large can covered with sheeting. At the end of three or four days, most of the maggots have pupated. The pupae are shaken out of the gauze and stored in the ice-box, or allowed to hatch, depending upon the need for additional flies. This procedure enables us to check up possible contamination by other species of flies. Furthermore, it eliminates the need for fume closets.

CLINICAL APPLICATION

During the past six months, twenty-nine cases have been treated by maggot therapy. These include: (1) *soft-tissue infections*—three cases of carbuncle, two cases of traumatic injuries, two cases of decubitus; (2) *compound fractures*—five cases, three of which were caused by gunshot wounds; (3) *bone infections*—one case of chronic osteomyelitis of the skull, eleven cases of infection of the long bones, two cases of infection of the foot, and three cases of osteitis of the jaw.

It was found that maggot therapy proved particularly effective in soft-tissue infections. The following cases are described in order to illustrate the versatility of maggot therapy and the adaptability of the cages to various types of infected wounds.

CASE 1. W. C., a white man, diabetic, sixty-nine years of age, was admitted with a carbuncle on the back of the neck, of two weeks' duration. No improvement resulted from incision and application of moist compresses. Two batches of maggots were applied, the patient being ambulatory throughout treatment, and the carbuncle was healed in twelve days.

CASE 2. A. S., a white man, twenty-one years of age, was admitted with laceration and contusion of the forearm. Little improvement was noted after treatment with hot

FIG. 7

Case 3. Photograph showing wound in osteomyelitis of the skull.

FIG. 8

Case 3. Photograph showing Type *B* cage in place.

compresses of magnesium sulphate and injections of staphylococcus and streptococcus bacteriophage. An area of ulceration, about six centimeters in diameter, was present on the outer side of the forearm, and the skin about the ulcer was undermined to a distance of about three centimeters. Numerous superficial ulcers were present. Following the application of two batches of maggots, healing was practically complete after nine days.

CASE 3. S. J., a colored man, twenty-nine years of age, was admitted with a condition diagnosed as osteomyelitis of the frontal bone. In the course of three operations, portions of the frontal and parietal bones were removed.

The wound did not heal, and maggot therapy was instituted (Figs. 7 and 8). Ten batches of maggots were applied, after which a roentgenogram showed some diseased bone still present. The patient refused further operation and was discharged with a hopeless prognosis.

The case just presented illustrates the adaptability of our cages. Both *A* and *B* types were used, and very few maggots escaped. As far as we have been able to ascertain, this is the first case of osteomyelitis of the skull in which maggot therapy has been attempted. Wilensky [16], in a very thorough article on osteomyelitis of the skull, suggested this method of treatment. The possibility that the maggots may penetrate the dura, which has been mentioned by some writers, is more theoretical than real, as in these cases the dura is very much thickened.

CASE 4. R. G., a white boy, three years of age, was admitted with a condition diagnosed as chronic osteomyelitis of the left mandible. A draining sinus was present. The bone did not heal after curettage. About six months later, another operation was performed and eight days afterward, maggots were applied, using the Type *A* cage (Fig. 6). The maggots were removed after three days. Two weeks later, the wound was completely healed.

This case again illustrates the adaptability of our cages to this type of wound. The patient was ambulatory and was unaware of the type of treatment. Two similar cases have since been completely cured.

SUMMARY

We have developed a technique of maggot culture and application which we believe greatly simplifies maggot therapy.

With this technique, one worker can rear enough maggots to treat some fifty patients at one time.

By means of cages such as we suggest, maggots may be confined to any type of wound on the exterior of the body.

Maggot-treated wounds need attention only once or twice in twenty-four hours, dependent drainage not being necessary.

If our methods are followed, the maggots will not die in the wounds.

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A REPORT OF FORTY CASES OF FRACTURE OF THE VERTEBRAE WITHOUT CORD SYMPTOMS *

BY R. F. BOWERS, M.D., NEW YORK, N. Y.

A study of the literature on fracture of the spine without cord symptoms shows great variations in the method of treatment and the period of hospitalization, but unfortunately leaves us in doubt as to the results obtained. It is the purpose of this paper to add to the literature a report of forty cases of fractured vertebrae without cord symptoms with the mode of treatment instituted and the results obtained, as far as they could be determined.

In four years (1924 to 1928) forty cases of this kind were observed at the Cincinnati General Hospital. With the exception of one, all of these cases were recent fractures, and the majority of these patients were brought to the Hospital immediately following the injury. Suspicious fractures of the spine are not included in this résumé; in each case the diagnosis was confirmed by x-ray.

Symptoms and Physical Findings:

The most constant single clinical sign in establishing the diagnosis of fracture of the vertebrae without cord symptoms is local pain with point tenderness. Every case but one of our series presented this symptom. Disability ranks second to pain in frequency. Several patients complained of inability to walk, and an analysis of our cases shows this disability to have been present in ninety per cent. Four patients walked into the Hospital; two patients were in a severe grade of shock but they had many associated injuries. A careful study of the clinical description and the pulse and temperature charts fails to reveal shock in the majority of our cases. Two patients were unconscious on admission; both had associated head injuries.

Referred Pain:

As far as our records show, four patients had pain referred to the posterior aspects of the thighs, and ten complained of mild abdominal pain. In one case of fracture of the ninth dorsal vertebra, the patient complained of difficult and painful respiration. He was slightly cyanotic; his respirations were rapid and shallow; but there was no definite evidence of fracture of the ribs or of an intrathoracic injury.

Deformity:

Kyphosis in a mild form was noted in but four cases.

* The cases reported were treated in the General Surgical Service of the Cincinnati General Hospital, with which institution the author was associated. His thanks are due this institution for permission to publish the study made there.

Crepitus:

In the cases with a fracture of the transverse processes it was possible to demonstrate crepitus in three.

Site of Lesion:

It has often been observed that the upper lumbar spine is the site of fracture in the majority of cases of fractured vertebrae. The first three lumbar vertebrae were fractured in thirty-seven of our forty cases. The distribution of the fractures with regard to individual vertebrae is as follows: second cervical, two; third cervical, two; fourth, fifth, and sixth cervicals, each one; ninth dorsal vertebra, two; and twelfth dorsal vertebra, three. In contrast with the cervical and dorsal vertebrae, the first lumbar vertebra was fractured in twelve instances; the second in fifteen; the third in ten; the fourth in five; and the fifth in three instances. In twenty-nine of the forty cases the fractures were crushing fractures of the vertebral body. In eleven cases the fractures were of the transverse processes only. There were ten cases in which more than one vertebra was fractured.

Treatment:

The treatment for the majority of cases consisted of immobilization of the spine in hyperextension for a period of six weeks. Following this period, a supporting back brace was applied, which was worn by the patient for a period of from six weeks to one year, depending upon the residue of pain, weakness, and disability. The type of brace used by preference was the Taylor back brace.

In thirty of the forty cases a body cast was applied. Five cases were treated by bed rest alone. Three of these patients had fractures of the transverse processes alone, and after six weeks in bed they were sent home without a back brace. They were advised to return to the Clinic if symptoms recurred, but none have returned. Five patients were sent home in casts and returned to the Clinic for removal of the casts and for application of the brace. Two patients left the Hospital before the institution of treatment.

Hospitalization:

The average number of hospital days for this group of patients was forty-four. The longest stay in the hospital for any one patient was sixty days.

Results:

It has been possible to follow thoroughly twenty-two of the forty cases. These have been observed for from two to five years following the injury.

Deaths:

No patient died directly from the injury. Two patients have died since leaving the Hospital, one of pneumonia in a neuropathic hospital, two months after discharge; the other of "heart failure", according to the relatives, four months after discharge.

Late Results of Fracture of the Transverse Processes:

Four of the eleven cases have been observed. Three of these patients are absolutely well; they have no pain or weakness; and examination of the back is negative at this time. The fourth patient complains of stiffness in the lumbosacral region and of pain in both buttocks. This patient had a fractured pelvis and three fractured ribs, besides fractures of the transverse processes of the fourth lumbar vertebra.

Late Results in the Crushing Fractures of the Lumbar and Dorsal Vertebrae:

Fifteen of these cases have been observed for from two to five years following the injury. Four of these patients are absolutely well; they have no pain in the back, no weakness, no disability; and physical examination is negative. Eleven patients complain of pain in the back upon lifting and stooping, and of weakness of the back. In ten of these cases the symptoms are said to be severe and in one mild.

Occupational Results:

No patient is totally incapacitated. Four patients of the entire group, excluding the two who died following discharge, have not been able to return to their regular work on account of residual disabilities from their injuries. The majority of the patients took up light work for a shorter or longer time following discharge. The average time for assuming light work following injury was nine months. The average time for return to regular duties was one year and two months. These figures do not include patients who did not return to their regular work.

This report shows, therefore, that thirty per cent. of the patients observed are free from symptoms and able to resume their regular work; twenty per cent. are thus far unable to take up their regular duties; seventy per cent. complain of symptoms which they state are a handicap in their work.

Examination:

The patients examined from two to five years after injury failed to show physical signs of the injury, with the exception of two. Both of these were cases of crushing fractures of the lumbar spine and presented point tenderness locally, slight limitation of motion, and definite but mild muscle spasm when motion was attempted. Definite kyphosis was present in these two.

SUMMARY

1. Fractures of the vertebrae without cord symptoms are the results of severe accidents affecting the upper lumbar spine in the majority of cases; and, although not to be compared in seriousness with those causing injury of the spinal cord, yet they are capable of producing distressing permanent symptoms.

2. Fractures of the transverse processes alone have, in this series, had practically no residual symptoms.

3. Seventy per cent. of the fractures of the crushing type in the dorsal and lumbar spine present pain in the back and weakness. A few of these patients are partially disabled.

4. No patient has been totally incapacitated due to the spinal injury. The average time of return to work following injury was from nine to fourteen months.

5. In view of these results, the question arises whether a longer period of primary immobilization would not yield better results.

NON-TUBERCULOUS INFECTIONS OF THE SPINE *

BY ARMITAGE WHITMAN, M.D., NEW YORK, N. Y.,
Surgeon, Hospital for Ruptured and Crippled

AND RAYMOND W. LEWIS, M.D., NEW YORK, N. Y.,
Roentgenologist, Hospital for Ruptured and Crippled

Among the various infections of the spine, tuberculosis and chronic osteo-arthritis or spondylitis are usually recognizable with a fair degree of certainty by their roentgenographic appearance, and the clinical and roentgenographic diagnoses can usually be made with considerable assurance.

Other known types of infection of the spine are: osteomyelitis, typhoid arthritis, lues, Neisserian infection, fungus infections, undulant fever, and unclassified infectious arthritis. We believe that only with considerable difficulty and uncertainty can these be recognized and classified roentgenographically and clinically. In a recent article, Smith [1] calls attention to a benign form of osteomyelitis of the spine which is very difficult to distinguish from tuberculosis. In his series, eleven out of seventeen cases had been previously diagnosed as tuberculosis by competent orthopaedic surgeons.

We are here reporting four cases which we believe to be cases of non-tuberculous spine infection. We are presenting these, partly because they are of interest in themselves, and partly to illustrate the extreme difficulty in making a definite diagnosis in these types of cases. Our discussion of the following cases indicates that there is still some uncertainty in our minds with regard to the diagnoses.

CASE REPORTS

CASE 1. Mrs. H. S. T., a woman of middle age, was first seen by one of us (A. W.) August 21, 1929. At that time there was a history of an abrupt onset of pain in the back eighteen months before, while seated in a theater. The patient was ill for the next four to seven weeks with what eminent consultants called intestinal influenza. The Widal test and blood culture were negative for typhoid. Wassermann and gonorrhœal complement-fixation tests were negative. At that time, she complained of considerable pain and stiffness of the back, which gradually increased. Several months later, when her condition permitted, she went abroad and used mud baths and similar therapeutic measures. She returned home and was fairly comfortable, although her back was stiff. Two months later (sixteen months after the original onset), following a motor trip, she experienced great pain in the back and the stiffness became much worse. Pain was spasmodic in character and was severe enough to require one-quarter of a grain of morphine three times a day. She had been confined to her bed for two months when first seen by us. Her temperature ran between 99 and 101 degrees.

August 23, 1929: The patient was moved to a hospital, where, under general anaes-

* Read before the Annual Meeting of the Alumni Society of the Hospital for Ruptured and Crippled, November 13, 1933.

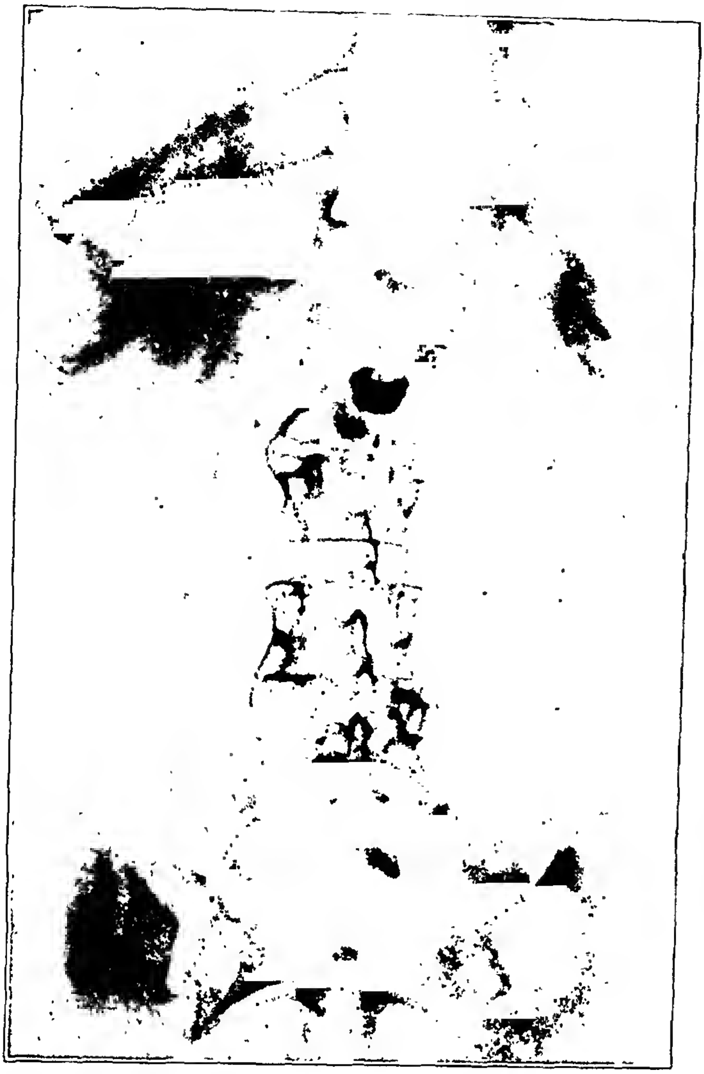

FIG. 1-A
Case 1. Mrs. H. S. T., September 9, 1931.

thesia, her back was stretched and placed in proper alignment, and a plaster jacket was applied. Operative fusion of the spine was refused by the patient.

September 24, 1929: Patient had had no pain for a week.

October 4, 1929: Patient was discharged wearing a plaster jacket.

January 17, 1930: The plaster jacket was removed and the patient was given a Knight spinal brace.

September 9, 1931: Roentgenograms of the lumbar spine (Figs. 1-A and 1-B) show six vertebrae of the lumbar type. The discs between the second and third and between the fourth and fifth bodies have been completely destroyed, and there is solid bony bridging between the adjacent margins of the second and third, and the fourth and fifth bodies.

September 24, 1931: Patient's back was stiff. Attempts at motion were not painful.

October 7, 1931: Patient went without a brace at night and in the forenoon, without pain. She has not been seen since and the consequent assumption is that she is well.

This case seems to belong either (1) to that broad and inclusive group called infectious arthritis, organism unknown, following what has been called, perhaps for lack of a better name, intestinal influenza; or (2) to the osteomyelitis group. It seems impossible to make a precise diagnosis of the spinal infection in this patient.

CASE 2. Mrs. C. G., aged twenty-nine, was seen first October 31, 1931, by Dr. L. C. Wagner. For a year previous she had had pain in the dorsal region about the right scapula. There was no history of injury. Her general condition was good.

Physical examination showed some stiffness of the neck and in flexion of the spine. Flexion of the neck caused pain around the lower border of the scapula and in the right breast.

Roentgenographic examination showed much narrowing of the intervertebral disc between the fifth and sixth dorsal vertebral bodies, with the narrowing a little more marked on the left side. There was no evidence of bone involvement.

Patient was given a Knight spinal brace, which she wore with relief of symptoms.

Roentgenographic examination on September 14, 1932, suggested a little bone proliferation on the left side (Figs. 2-A and 2-B).

There is no history of trauma to suggest injury to the nucleus pulposus of the intervertebral disc. The history, examination, and course do not suggest tuberculosis, although this cannot be excluded absolutely as a possibility. The most likely diagnosis would seem to be unclassified infectious arthritis.

FIG. 1-B

Case 1. Mrs. H. S. T., September 9, 1931.

CASE 3. Mr. C. F., aged twenty, was first seen on September 1, 1931. There was a history of severe aching pain in the lumbosacral region of two months' duration. There was no known etiology except overexertion brought about by lifting stones at a summer camp. There were no constitutional symptoms.

Roentgenographic examination, August 10, 1931, showed a rounded area of bone destruction and bone production at the anterior superior margin of the body of the third lumbar vertebra, and considerable narrowing of the disc between the second and third bodies (Figs. 3-A and 3-B).

Pain became worse during the following two weeks. There was no history of infection or venereal disease; no fever. Patient was confined to his bed, with considerable relief of symptoms.

October 21, 1931: A plaster jacket was applied and immediate relief was obtained. After two weeks in plaster, the patient was given a brace. His general condition was excellent.

September 8, 1932: Clinically, complete recovery had taken place. The roentgenogram (Fig. 4) showed a filling in with new bone of the area of bone destruction in the third lumbar body.

Despite the mildness of the local symptoms and the absence of constitutional symptoms, this is probably a case of low-grade pyogenic abscess of a vertebral body, with involvement of the intervertebral disc. Another possible diagnosis, injury and herniation of the nucleus pulposus of the intervertebral disc, seems less likely.

CASE 4.* Mr. H. W., aged twenty-two years, was first seen by Dr. Stewart on February 9, 1932. There was a history of four discharging sinuses:

Left groin, six years' duration
Lumbosacral region, five years' duration
Over right hip, six months' duration
Over right sacro-iliac region, six months' duration.

Eight years previously he had had many boils.

FIG. 2-A

Case 2. Mrs. C. G., September 14, 1932.

* This case is included through the courtesy of the late Dr. George David Stewart.

May 1924: Present illness began with a high temperature and severe pain in the small of the back. A so called cold abscess developed in the left groin, which disappeared in two months, following rest in bed and medical treatment.

November 1926: The cold abscess had reappeared, was opened, and is still draining.

May 1927: Another abscess was opened.

During 1929, the patient spent considerable time in the Desert Sanatorium. Repeated smears and cultures from the pus failed to show tubercle bacillus. Twenty or more guinea-pigs were injected with the pus, but showed no evidence of tuberculosis.

November 1930: Patient was confined to his bed with a high temperature and pain. One of the sinuses ruptured into the rectum. He was in bed for six months.

June 1931: Rollier's treatment was started.

July 1931: The abscess above the right hip was opened, and is still draining.

August 1931: The abscess over the right sacro-iliac region was opened, and is still draining.

On February 9, 1932, Dr. Stewart picked a small piece of bone out of one of the sinuses.

Roentgenographic examination, February 13, 1932, with injection of a twelve per cent. solution of sodium iodide into the sinuses, showed considerable narrowing of the intervertebral disc between the fourth and fifth lumbar bodies, slight roughening of the adjacent surfaces of these bodies, and erosion of the right transverse process of the fifth lumbar vertebra. A small sequestrum lay in the tissues lateral to the transverse process. The iodide showed that the sinuses led down to the right fifth lumbar transverse process, and to the right of the bodies of the fourth and fifth lumbar vertebrae.

On November 14, 1932, the roentgenographic examination showed conditions essentially the same as before (Figs. 5-A and 5-B).

Fig. 2-B

Case 2. Mrs. C. G., September 14, 1932.

The laboratory examination at the Desert Sanatorium and, especially, the findings obtained from the

Fig. 4
Case 3. Mr. C. F., September 8, 1932.

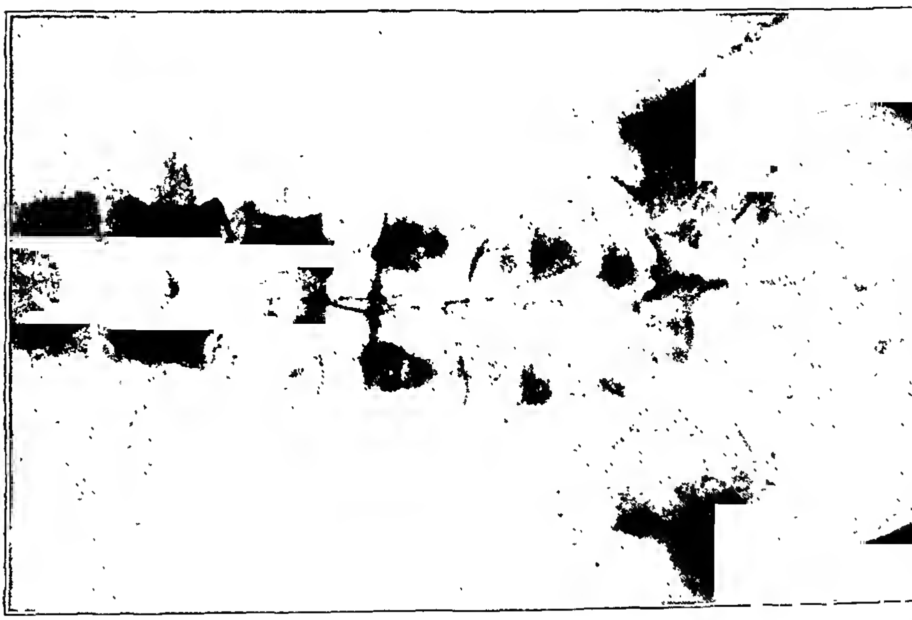

Fig. 3-B
Case 3. Mr. C. F., August 10, 1931.

Fig. 3-A
Case 3. Mr. C. F., August 10, 1931.

Fig. 5-A

Case 4. Mr. H. W., November 14, 1932.

Fig. 5-B

Case 4. Mr. H. W., November 14, 1932.

guinea-pig injections, seem to exclude tuberculosis. The history of boils prior to onset of the condition furnished a possible source of the spine infection. This case is probably a chronic non-tuberculous osteomyelitis and arthritis of the spine.

SUMMARY

1. Non-tuberculous infections of the spine are often difficult to diagnose as such, and their classification is frequently extremely difficult.

2. Four cases, believed to be non-tuberculous infections of the spine, are presented and discussed with regard to diagnosis.

1. Smith, Alan DeForest: A Benign Form of Osteomyelitis of the Spine. J. Am. Med. Assn., CI, 335, 1933.

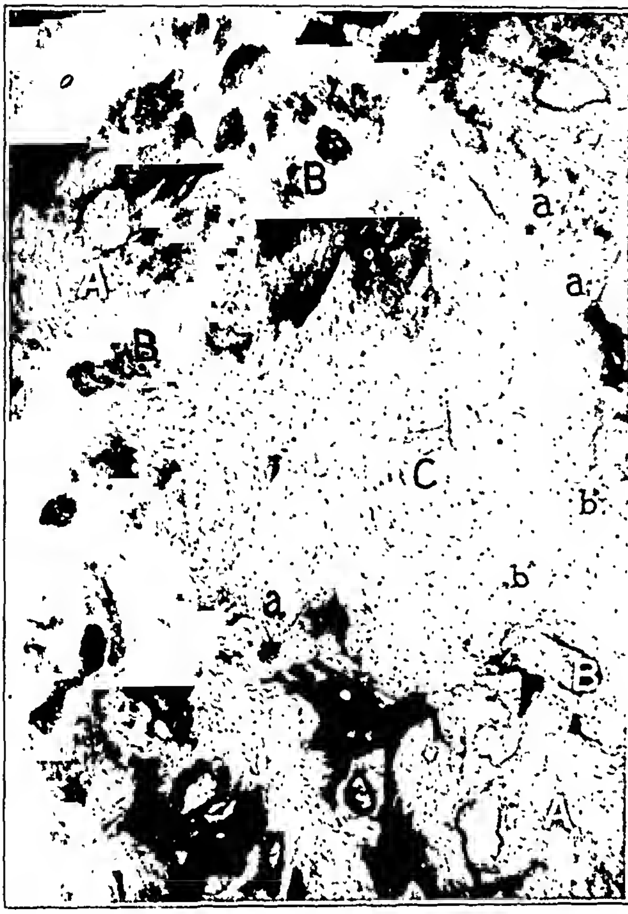

Fig. 2

Photomicrograph showing markedly sclerotic, necrotic Paget's bone of primitive character (A), with large basophilic portion, suggesting mosaic structure (B). By osteoclastic bone resorption (a), the enlarged marrow space (C) is filled with dense fibrous marrow containing free giant cells (b).

markedly porotic, and has the structure and the consistency of soapstone. The periosteum seems to be thickened and, in many places, to be involved by tumor tissue. The bone tissue in the epiphysis shows unusual sclerosis, but almost all of this sclerotic bone appears to be necrotic.

There was invasion of the popliteal vein by tumor tissue, and tumor emboli were found in many branches of the pulmonary artery. A fibrinopurulent pleurisy was found over the left lower lobe, and there was more than two liters of exudate in the right pleural cavity. There existed a purulent infarction in the right lower lobe, with necrosis of the pleura and empyema. There was present, by transmigration, a fresh fibrinopurulent pericarditis. All of the other findings were essentially negative. Unfortunately no other parts of the skeleton were examined.

Parts of the lower end of the femur and of the upper end of the tibia were taken for histological examination. Fourteen different sites were studied, but only those facts which are of most interest will be mentioned.

All the sections show the typical picture of Paget's disease (Figs. 2, 3, 4, and 5).

The findings in the lower end of the femur were as follows: in most places, the bone shows an advanced stage of Paget's disease. The bony trabeculae are thick and irregular and are made up for the most part of lamellar bone. Thick dark-blue cement lines unite irregular lacunar pieces of lamellar and fibrous bone, thus giving rise to the mosaic structure of Schmorl, which is typical of Paget's disease. Where a more acute picture of Paget's disease is present, which is the case in the subperiosteal zone of the femur (Fig. 4) and in the peripheral parts of the condyles, we find a very dense cancellous bone formed by thin trabeculae of fibrous bone, partly calcified and in part still osteoid. These bony trabeculae are formed on the basis of the loose fibrous bone marrow, at first entirely without the participation of the osteoblasts. The osteoblasts appear somewhat later and lay down osteoid tissue on the surface of the fibrous bony trabeculae. But, at the same time, multinuclear cells (osteoclasts) can be

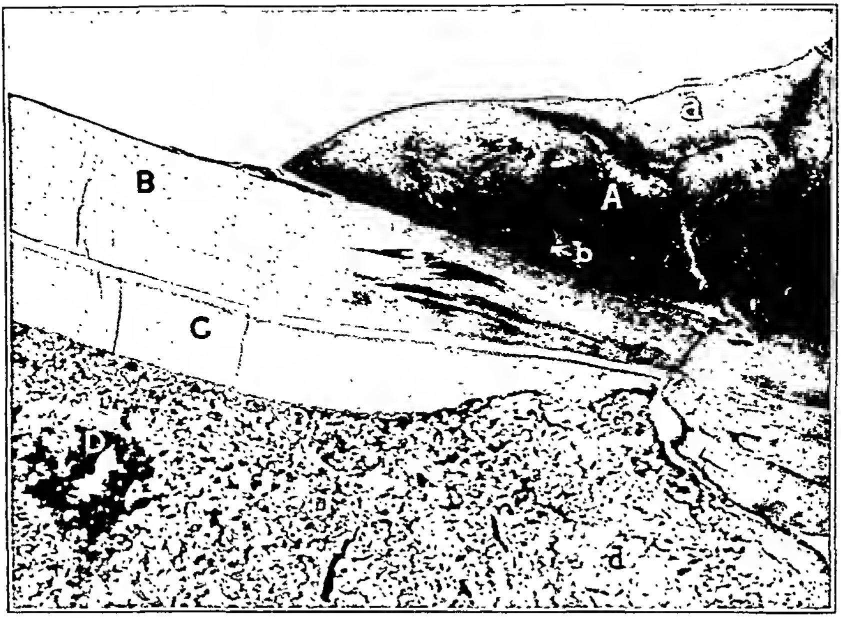

FIG. 3

Photomicrograph showing: invasion of the knee joint by tumor tissue (*A*), covering semilunar cartilage (*B*); a layer of fibrinous exudate (*a*); a tumor thrombus in the vein (*b*); normal joint cartilage of the tibia (*C*); subchondral zone (*D*) with Paget's bone in fibrous bone marrow, forming small marginal exostosis (*c*); normal fatty bone marrow (*d*).

observed bringing about lacunar resorption of the newly formed bony trabeculae. These rapid changes of bone formation, bone apposition, and bone resorption finally lead to the complex picture of Paget's bone. Depending upon whether bone apposition or bone resorption is in the preponderance, osteosclerosis or osteoporosis, respectively, will result. In some areas the activity of the osteoclasts is so pronounced that the bony tissues become absorbed in a very extensive way. This resorption may be so great that, in a roentgenogram, these areas may even appear cyst-like,—pseudocyst in Paget's disease [1]. In those areas where bone apposition is prevalent, the histological picture is more quiescent; the surface of the bony trabeculae is smooth, surrounded by osteoblasts with osteoid tissue; and lamellar bone is by far more prevalent than fibrous bone. There can result very marked osteosclerosis, with islands of almost compact bone within the spongiosa. From the pathological point of view, these photomicrographs may be interpreted as showing a healing stage of Paget's disease.

The picture is considerably different in the upper end of the tibia (Fig. 3). Here, the changes are undoubtedly of more recent character. They are florid in the subperiosteal zones and are more porotic in character in the middle of the epiphysis. The bony trabeculae show a composite character,—*i.e.*, several smaller bony trabeculae, with a typical picture of Paget's bone, are joined together by strips of fibrous marrow. The wide

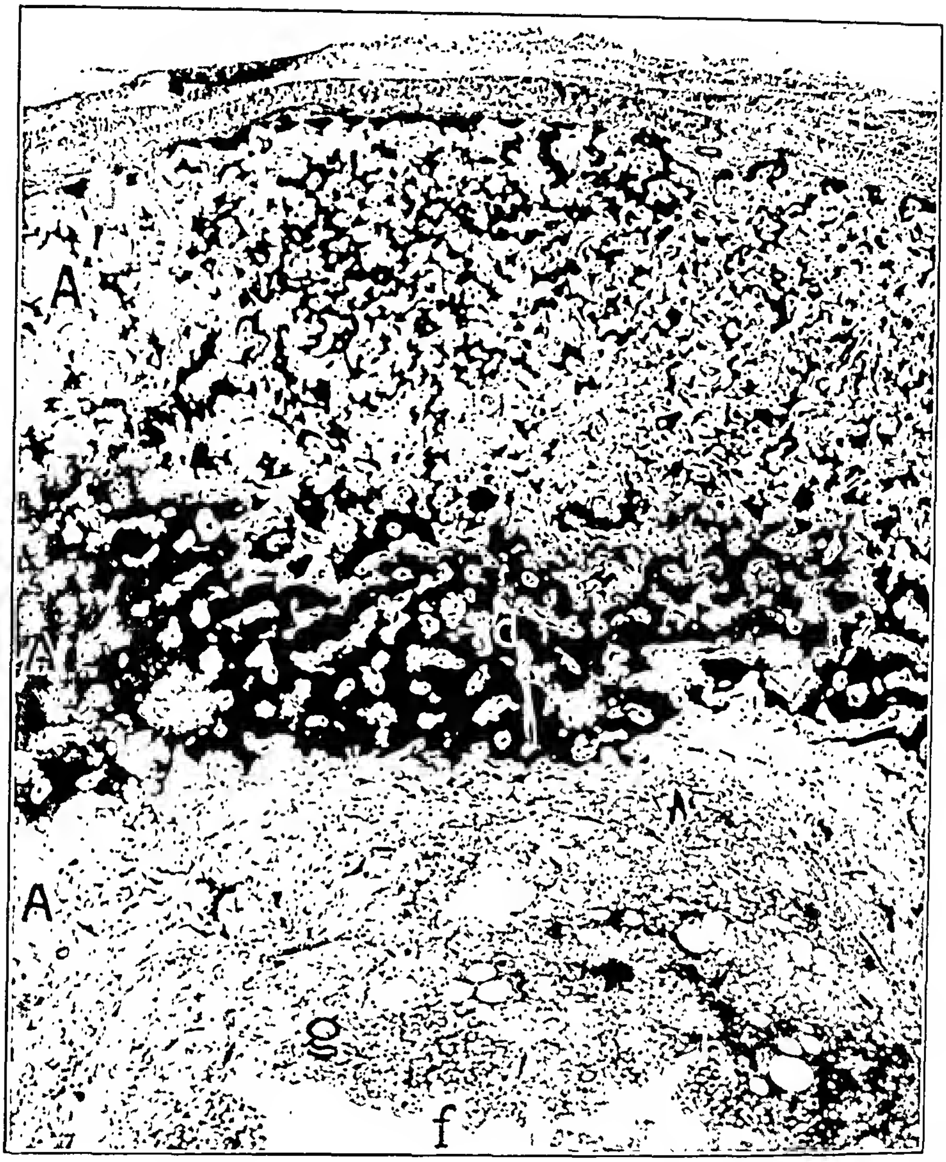

Fig. 4

Cross section through the femoral diaphysis showing: hyperostotic, porotic changes of cortical bone (*A*); subperiosteal zone (*a*) with small bony trabeculae in dense (*b*) and loose (*c*) fibrous bone marrow; more dense cortical bone (*d*) with focus of beginning sarcoma formation (*e*); marrow cavity (*f*) with fatty bone marrow (*g*), showing necrotic tumor tissue (*h*); a thin layer of periosteum with atrophic musculature (*i*).

marrow spaces between these strips are filled with perfectly normal cellular and fatty bone marrow. In these areas, which apparently show earlier stages of Paget's disease, some difference in the arrangement of the bony trabeculae can be noted in various places, a difference which very likely is founded on a mechanical basis. The area adjacent to the insertion of the crucial ligaments, for instance, shows a more advanced picture of Paget's disease and a denser bony structure. It is known from the investigations of Schmorl and Freund that areas with more marked mechanical irritation show the changes of Paget's disease first, such as the zones directly below and above the intervertebral discs. In our case a static structure of

Fig. 5

Photomicrograph showing tumor nodule (*A*) in the subchondral zone of the lateral femoral condyle: marked osteoporosis, with subchondral Paget's bone (*a*) and fibrous bone marrow (*b*); fracture (*c*) of joint cartilage with downward displacement of one fragment and overlapping of the other.

The tumor nodule shows a central portion, with typical structure of spindle-cell sarcoma, and a more peripheral portion (*d*), which is cellular. A tumor capsule is formed by the surrounding bone marrow (*e*).

Paget's bone can be seen in the upper end of the tibia, which bone as a rule does not obey static laws. Here, the bony trabeculae show an extremely fine radial arrangement to the joint surface.

Differences can also be seen in the fibrous bone marrow. There is certainly not always the same picture with the same density of the fibers.

In places where the more acute changes occur, the bone marrow is rather loose (Fig. 4). In this loose bone marrow many blood vessels are seen, and in some places free red blood cells are visible in the tissues; in other places, there are found occasionally small islands of perivascular round-cell infiltration. In some areas the fibrous bone marrow includes small foci of fat cells which probably are remains of the old fatty bone marrow.

As the process goes on over a period of years, the fibrous bone marrow becomes more mature,—*i.e.*, the fibers are denser (Fig. 4), the marrow is less vascular, and the number of cells is decreasing. In the more central portion of the femoral diaphysis, close to the marrow cavity, extensive areas can be seen with marked hyaline degeneration of the fibers.

It is of great interest that tumor tissue can be seen only in places that show a highly mature fibrous marrow. The areas in which the fibrous marrow gives the impression of being young and active—where the typical florid picture of Paget's disease, with the small and dense trabeculae of fibrous bone, is seen—are free of any tumor tissue. It has already been mentioned that the tumor tissue showed extensive necrosis, due to the pathological fracture. This rendered the histological investigation a little more difficult, but a clear idea of the tumor growth was finally obtained.

Near the intercondyloid fossae of the femur the marrow spaces are filled with polymorphocellular tissue. The cells are large; the protoplasm is very light and almost foamy. The nuclei are of different sizes, but, in general, are large and poor in chromatin. Frequently, mitotic figures can be seen. Cells with two or more nuclei are not rare. In these marrow spaces very few fibers can be seen between the cells. There is, however, marked osteoclastic bone resorption going on around the endosteal surface of the marrow spaces.

In other places, the picture is quite different (Fig. 6). The cells show more uniformity, the nuclei are darker, the protoplasm is spindle-shaped, and between the cells connective-tissue fibers are present. Cells and fibers are arranged in bundles in which giant cells and mitotic figures are present frequently. These findings are very typical of a rather rapidly growing spindle-cell sarcoma; whereas the areas with the irregular and large protoplasmic cells correspond exactly to the description by von Albertini [2] of what he calls the "presarcomatous stage" of Paget's bone marrow.

From a careful study of different sites in the femoral diaphysis, one gathers the impression that the tumor growth started independently at the same time in these different places (Figs. 4 and 5). There are two areas which point this out particularly well,—one a marrow space in the cortex of the diaphysis; the other in the subchondral zone of the lateral femoral condyle. The first area shows very active enlargement by osteoclasts. The marrow space is filled with a rather cellular tissue containing giant and spindle cells, and there is a beginning arrangement of fiber bundles. This marrow space stands out from the surrounding tissue and there can be no doubt that here sarcoma formation is just beginning.

This shows, however, that von Albertini's "presarcomatous stage" is not absolutely necessary in sarcoma formation in Paget's bone marrow.

The other area shows grossly a grayish-white, dry, and slightly granulated tumor nodule, which is sharply outlined (Fig. 5). Microscopically, the focus is composed for the most part of spindle cells, with fibers arranged in bundles. The central portion shows relatively more fibers and even hyaline degeneration of the fibers. Toward the periphery the cells are more prevalent. Here also, most of the cells are spindle-shaped, but among these there are quite a number of different cells, even giant cells, and mitoses are quite frequently found. The dense fibrous structure in the central portion loosens up almost immediately toward the periphery, the fibers are scarcer, and the cells become very protoplasmic and, by pressure, almost polygonal in shape. This layer corresponds to those cellular tumor areas already mentioned, the "presarcomatous stage" of von Albertini[2]. Where this cellular zone touches the bone marrow, the latter shows a kind of capsule formation, which, grossly, made the tumor nodule stand out sharply. This capsule formation is nothing more than the compression of the bone-marrow fibers by the expanding tumor growth. But it is interesting that the bone marrow near this zone is very rich in mononuclear cells with a reddish protoplasm. The nucleus is at the center or in the periphery and is smaller than in the polygonal cells in the tumor zone. These cells are histiocytes, furnished by the bone marrow, and they certainly represent a reaction to the tumoı growth.

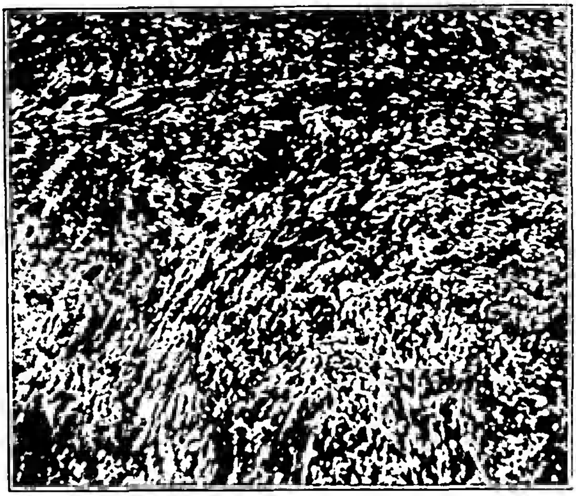

Fig. 6
Spindle-cell sarcoma with giant cells.

Because of its sharp outline, it may be that this tumor nodule represents a metastasis in the bone marrow rather than a primary tumor formation. But, inasmuch as there are several cases already reported to show that a multicentric tumor growth can take place in Paget's disease (von Albertini[2], Wanke[3], Schmorl[4]), we are also more inclined to this assumption in our case.

As already mentioned in the macroscopic description, the tumor in the lower end of the femur invaded the knee joint (Fig. 3). Despite extensive necrosis of the tumor tissue at this area, the structure is still

plainly visible. After osteoclastic removal of the bony lamellae in the intercondyloid fossae, the tumor followed closely the synovial layer along the crucial ligament. It grew along the ligament from femur to tibia and covered the semilunar cartilage in a thick layer. The superficial portions, which very likely received nutrition from the synovial fluid, are well preserved, whereas the deeper portions underwent necrosis. Where the necrosis of the tumor tissue in the knee joint is more extensive, the synovial membrane shows a marked degree of hyperaemia, with formation of granulation tissue, and the direction of almost all of the capillaries is toward the necrotic tumor tissue. The invasion of necrotic tumor tissue by newly formed granulation tissue represents the first attempt at a reorganizing process.

Of interest also are the changes in the knee joint, due to the intra-articular fracture (Fig. 5). The fracture of the cartilage occurred just over the area of marked osteoporosis in the central portion of the lateral femoral condyle, which showed also the sharply outlined tumor nodule. The highly porotic bone did not support the joint cartilage adequately, so that even a slight increase in intra-articular pressure could give rise to a displacement of joint cartilage toward the marrow spaces. And, as a matter of fact, a slight trough in the middle of the joint surface was found, which, macroscopically, did not look so deep because it was filled by a layer of coagulated fibrin in an advanced stage of organization. The depression is almost smoothed out by the superimposition of the cartilaginous fragments. More marked than the depression of the surface is the displacement of the deeper layers. This can clearly be judged by the discontinuity and the displacement of the subchondral hard substances. Instead of forming a continuous line, the zone of preparatory calcification and the subchondral bony lamellae show an abrupt interruption, and one fragment is displaced downward for almost two millimeters. There is no necrosis of the cartilage cells, but there are distinct changes in their structure. The displaced fragment of hyaline cartilage assumes a distinctly fibrous structure, with the direction of the fibers from the joint surface to the fibrous marrow. For mechanical reasons this corresponds to the "*Umprägung*" of hyaline cartilage (Schaffer). Along the fracture line, through the calcified cartilage and the underlying bony lamellae, the bone marrow comes in contact with the non-calcified cartilage. Here, the cartilage becomes invaded by bone marrow through an incomplete resorptive process described by Weichselbaum and Pommer. The hyaline ground substance of the cartilage disappears and the collagenous fibers of the cartilage become denuded. These fibers show, then, blending with the neighboring fibrous bone marrow, similar to the anchorage of fibrous tissue in bone shown by Sharpey's fibers. Inasmuch as by this resorptive process cartilage is not more completely lost, this fact may be interpreted, in this particular case, as an attempt at consolidation of the fracture of the joint cartilage by a rather firm union with the bone marrow.

CONCLUSIONS

A case of Paget's disease of bone is presented in which sarcoma formation occurred in the lower end of the femur, and, apparently, at the same time in other areas. The histological picture of the tumor varies from polymorphonuclear sarcoma to spindle-cell sarcoma and fibrosarcoma. The tumor led to pathological fracture at the lower end of the femur, and to invasion of the cavity of the knee joint and of the popliteal vein, with sarcoma metastases in the lungs.

It seems that osteitis fibrosa is the predisposing cause of the tumor growth, because only those portions with very mature fibrous bone marrow show tumor formation, whereas the parts with looser bone marrow and younger bony changes, in the sense of Paget's disease, are not affected by tumor growth. It is questionable whether von Albertini's distinction between a presarcomatous and a real sarcoma formation can be made.

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CORRECTION OF LATERAL COMPRESSION FRACTURE OF A LUMBAR VERTEBRA*

BY LEO MAYER, M.D., NEW YORK, N. Y.

Since 1927, when Arthur Davis, of Erie, Pennsylvania, demonstrated a method of correcting the anterior compression of the vertebral body in fractures of the spine, an extensive literature dealing with this topic has sprung into being. Despite the thoroughness with which the subject has been treated, no mention has thus far been made of the correction of a

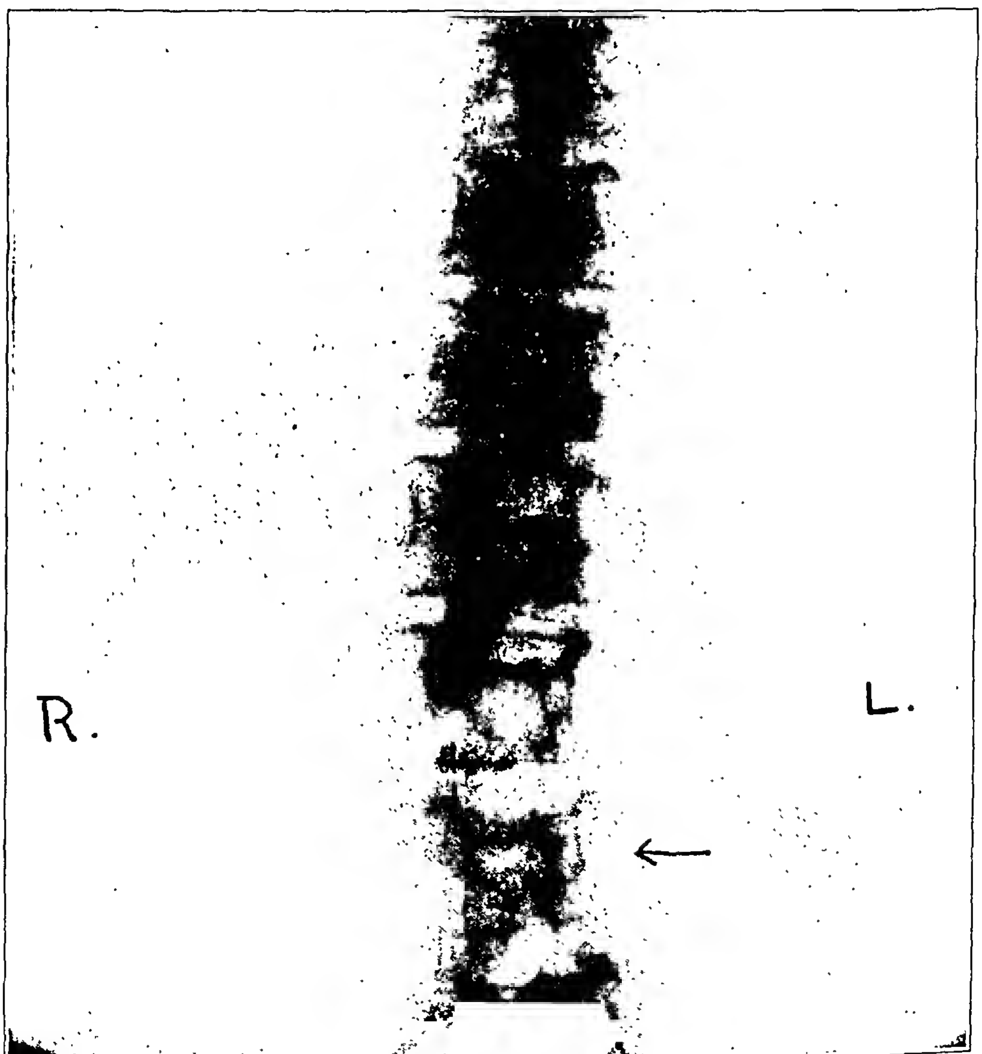

FIG. 1

Anteroposterior view of the lumbar and dorsal spine, one week after the accident. Note the compression of the left side of the second lumbar vertebra, as indicated by the arrow.

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closely related deformity,—namely, lateral compression of a vertebral body. Though it is true that this type of compression is less frequent than the anterior type, its recognition and correction are equally important.

Just as anterior compression is usually caused by a force which doubles up the individual like a jack-knife, so the lateral compression is caused by a trauma which produces a sudden lateral impaction. It is seen most frequently in industrial accidents where the workman, in falling from a height, strikes an impediment—either a beam or a pipe—with the side of the body. But it can also occur as the result of less serious accidents, as in the following case.

FIG. 2

Lateral view of the lumbar spine, one week after accident. The arrows indicate the direction of the line of fracture through the second lumbar vertebra. No anterior compression of the body is evident.

CASE REPORT

Mrs. O. W., aged fifty-three years, was thrown from her horse and landed on her left side. Though suffering pain in the mid-spinal region and the lower left chest, she continued to be up and about. Thinking that she was merely bruised, she waited an entire week before consulting her physician.

When first seen by the author, eight days after the accident, the outstanding physical sign was a tilt of twenty degrees of the back toward the left. There was, in addition, marked tenderness in the region of the second lumbar vertebra, muscle spasm preventing motion of the lumbar and dorsal spine, and tenderness of the lower ribs on the left side. The reflexes were normal. There were no sensory changes. The patient had no bladder or rectal disturbances.

The lateral roentgenogram of the spine showed a fracture of the second lumbar vertebra (Fig. 2), with no compression of the anterior portion of the vertebra. The line of fracture ran from above downward and backward. In the anteroposterior view (Fig. 1) was seen a lateral tilting of the spine toward the left. This was

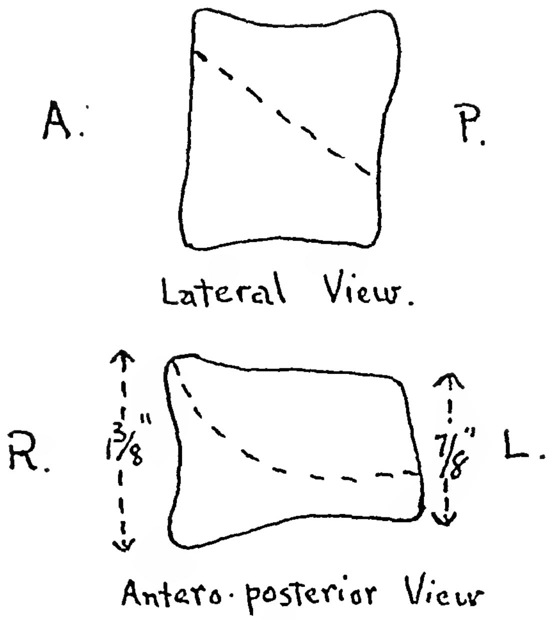

Fig. 3

Tracing of the lateral and anteroposterior roentgenograms, taken one week after the accident. The direction of the fracture is indicated by dotted lines. The left border of the second lumbar vertebra measures one-half an inch less than the right.

obviously due to the compression of the lateral half of the second lumbar vertebra. Measurements of the borders of the vertebra proved the left to be one-half an inch shorter than the right (Fig. 3). The line of fracture ran obliquely downward from the upper right corner of the body toward the lower left corner. Careful study of the film demonstrated increased density of the bone for about a half inch in the region of the fracture line. This was best seen near the left border of the vertebra, becoming less distinct as the fracture line was traced toward the right. It seemed reasonable to explain this increased density by an impaction of the two vertebral fragments. The articular processes of the left side, both the upper and the lower, showed a slight displacement, but there was visible no definite line of fracture running through the pedicles or laminae. The eleventh rib on the left side showed a comminuted fracture which had no clinical significance other than indicating the direction of the trauma.

It was obvious that the patient had suffered a fracture of the second lumbar vertebra, with a definite compression of the left side of the body.

Although the literature on fractures of the spine contained no allusion to the correction of this type of deformity, the author could see no reason why the impaction could not be reduced and the vertebral fragments maintained in alignment by a simple modification of the principles applicable to an anterior compression fracture. The all-im-

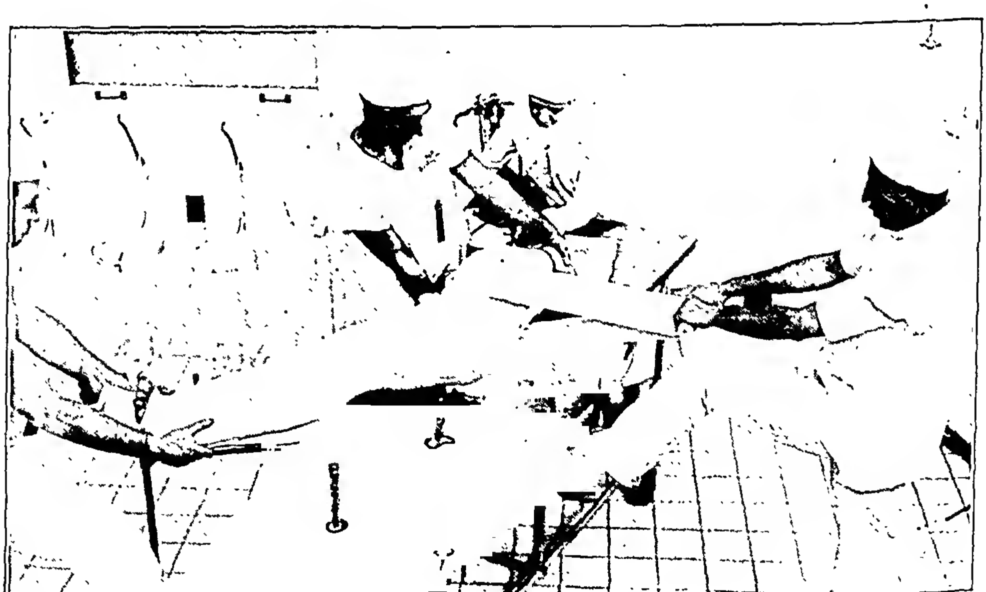

Fig. 4

Photograph indicating the manipulation employed to correct the compression of the left half of the second lumbar vertebra.

Fig. 5

Anteroposterior view of the lumbar spine, taken four weeks after the application of the corrective plaster-of-Paris cast. Note that the compression of the left half of the second lumbar vertebra has been entirely corrected.

Fig. 6

Lateral view, taken four weeks after application of the corrective plaster-of-Paris jacket, showing the absence of deformity in this plane.

portant fact demonstrated by Davis was that the intervertebral ligaments are strong enough, when tensed to their physiological limit, to disengage a recent vertebral impacted fracture. In the case of anterior compression, the anterior spinal ligament acts as the effective traction mechanism. If the compression is lateral, the ligaments joining the lateral portions of the vertebrae will, when stretched to their physiological limit, act to disengage the impacted fragments.

With this principle in mind, the following procedure was undertaken.

Although spinal anesthesia might be used, avertin, supplemented by gas-oxygen, was administered to the patient. A stockinet undergarment covered both legs and the trunk. The patient's pelvis was placed on a hip rest, the legs and trunk supported by assistants. A piece of heavy felt, about a foot square, was placed on the patient's right side with its center at the level of the second lumbar vertebra. A broad muslin bandage was slung about the body to hold the felt pad in position, and the ends were wrapped about a stick to prevent wrinkling. One assistant then made traction on the muslin band toward the side of the compression, and a second assistant swung the legs and the pelvis in the opposite direction, thus fixing the distal fragment of the fractured vertebra. The disengagement of the impacted fragments was accomplished by slowly swinging the trunk away from the side of the compression until the limit of lateral mobility had been reached (Fig. 4). The body had thus been brought to form almost a semicircle, with the fractured vertebra situated near the middle of the arc. A roentgenogram, taken while the patient was held in this position, showed correction of the deformity of the second lumbar vertebra. With the patient in the position of maximum correction, a double plaster-of-Paris spica was applied from the knees to the axillae. This spica was left in place for one month and was then replaced by a lighter plaster spica which included the left thigh only. Two weeks later, with the body in the erect position, a plaster corset was applied and the patient was allowed to be out of bed for a few minutes each day. Gradually the period of weight-bearing was increased and, in addition, the patient was given abdominal and back exercises. Within two months from the reduction of the fracture, the patient was able to stand quite erect without any support (Fig. 7). Although she had no pain whatever, it seemed the part of wisdom to have her wear a light brace for another two months. The final result is shown in Figures 5, 6, and 7.

FIG. 7

Photograph of patient, eight weeks after the accident, showing complete correction of the lateral tilting of the body.

SUMMARY

A case of lateral compression fracture of the second lumbar vertebra is presented, in which complete permanent correction of the deformity was accomplished by manipulation and immobilization in plaster-of-Paris.

PATHOLOGICAL CHANGES OF MUSCLES IN THE COMMON DISEASES OF CHILDREN

Their Relationship to Scoliosis

BY JOHN G. KUHNS, M.D., BOSTON, MASSACHUSETTS

From the Department of Pathology of the Children's Hospital, Boston

Few diseases are limited, in the pathological changes which they produce, to one organ or to one tissue of the body. While the damage in some tissues may be slight and may be healed quickly, if the organism survives, the injury in other tissues may be more lasting, the severity of the injury usually being proportionate to the severity of the disease and the regenerative ability of the involved tissues. Where there is serious damage to the tissues, complete recovery often does not occur, and what repair takes place is often dependent upon careful guidance and the avoidance of undue strain upon the physiological function of that particular organ for a long period of time. Cardiac and renal tissues are among the more common examples of such damage following juvenile diseases.

It has long been known that extensive, pathological changes may occur in the skeletal musculature after certain infectious diseases. The muscles most frequently involved have been found to be the diaphragm and the rectus abdominis.[1] The pathological changes have been interpreted for the most part, not as direct infections by microorganisms, but as injuries due to an intoxication or other physiological disturbances subsequent to a systemic disease.[2]

In order to determine the frequency and severity of these muscular changes, an examination was made of the muscular tissue obtained at autopsy from 100 children varying in age from premature infants to fifteen years. Since the major interest lay in showing a possible relationship between these muscular changes and the development of scoliosis, the muscular tissue was taken from the muscle groups which support the spine,—the rectus abdominis, the iliopsoas, and the erector spinae. Transverse and longitudinal sections were cut from all specimens. These were stained routinely with hematoxylin and eosin. Duplicate sections were stained either with phosphotungstic acid or with Mallory's aniline blue to show connective-tissue fibers. A number of sections were stained by the Bielschowsky method of silver impregnation to show the myoneural junctions. No abnormal changes were observed in the nerves stained in this manner. The usual pathological changes found in the muscles were those called hyaline or Zenker's degeneration.[3, 4, 5]

A wide variation in the frequency and extent of these hyaline changes[6] has been observed.[7, 8] Zenker[3] found these changes almost constantly in typhoid fever and, more rarely, in other diseases in which the entire muscle

was sometimes involved. Stemmler [9], Wolbach [10], Forbus [11], and Stenström [12] found hyaline degeneration of skeletal muscles after severe illness, with occasional complete rupture of the rectus abdominis muscle. These changes in musculature have been seen also in anaphylaxis [13] and intoxication [1].

Other changes leading to temporary or permanent weakening of muscles following various diseases have been reported occasionally. Abscess formation [14], fibrosis [15], infectious myositis [16], syphilis [17], tuberculosis [18], and amyloid deposition [12] have been observed. Tumors [19] rarely metastasize to muscles, but frequently destroy musculature by direct extension. Bone [20] may form in muscle either by implantation of bone-forming cells or by direct metaplasia of muscular tissue. After prolonged dietary deficiencies [21], degeneration [22, 23] and fat deposition have been observed in the muscles.

All of these changes, except ossification and tuberculosis, were

TABLE I

STUDY OF MUSCULAR TISSUE OBTAINED FROM 100 CHILDREN AT AUTOPSY

Causes of Death	Range of Ages				Pathological Changes		
	Under One Year	One to Four Years	Four to Eight Years	Over Eight Years	Marked	Slight	Negative
Pneumonia and other pulmonary infections	15	9	1	0	4	15	6
Septicaemia and overwhelming infection	9	5	5	1	5	11	4
Prematurity and congenital malformations incompatible with life	13	0	0	0	0	5	8
Nutritional disturbances	7	3	1	0	1	6	4
Meningitis—influenza and meningococcus	2	3	1	0	0	3	3
Congenital heart disease	4	0	1	0	0	1	4
Congenital syphilis	5	0	0	0	1	4	0
Tuberculous meningitis	0	3	1	0	0	0	4
Blood diseases	2	1	0	0	0	2	1
Intracranial hemorrhage	2	0	0	0	0	1	1
Poliomyelitis	0	0	1	0	0	1	0
Tuberculous peritonitis	0	1	0	0	0	1	0
Craniopharyngioma	0	0	0	1	0	0	1
Nephritis	0	0	1	0	1	0	0
Rhabdomyosarcoma	0	1	0	0	1	0	0
Amyloid disease	0	0	0	1	1	0	0

observed in the muscular tissue studied in this series. In Table I, the diseases are grouped for convenience. No difference was observed between the muscular changes in boys and in girls; nor was any appreciable difference found in regard to age [12]. The pathological changes in the muscles were graded as marked, slight, or negative. Loss of striations in scattered muscle fibers or irregularity of staining without any other change were not considered to be of pathological significance.

FINDINGS

In twenty-five cases that came to autopsy, death was due to pulmonary infections. Of these, there were twenty cases of bronchopneumonia. The muscular tissue removed showed extensive hyaline degeneration in two cases and less severe degeneration in fourteen others. There were three autopsies performed on children who had died from empyema. Of these three children, one showed extensive muscular degeneration; another, slight muscular changes; and the third, no pathological changes in the muscles. The pathological picture which was usually most marked in the rectus abdominis muscle was similar to that described by Forbus[11], Stemmler [9], and Stenström [12]. Oedema was frequently observed, with loss of striations in various regions. There were also areas of hyaline degeneration, which varied considerably in extent in the different cases, at times accompanied by leukocytic infiltration and active proliferation of nuclei of the muscle cells (Fig. 1). Small intramuscular hemorrhages were occasionally observed. In no case was there evidence of rupture of the muscle. The gross appearance of the muscular tissue removed for study gave little evidence of the extent of the pathological changes.

Twenty children died from septicaemia or an overwhelming infection. Cultures taken from the blood before death showed organisms in eight cases,—hemolytic streptococcus in seven, and staphylococcus aureus in one. Cultures were obtained from the blood at autopsy in twelve cases; eight showed hemolytic streptococcus and four, staphylococcus aureus. There were four cases diagnosed primarily as septicaemia, three cases of streptococcal tracheitis, three of sinus thrombosis, three of cellulitis, two of peritonitis, and one each of osteomyelitis, mastoiditis, stomatitis, pyelonephritis, and brain abscess. In this group with severe infections, chiefly from streptococci, the muscular tissue showed rather widespread degenerative changes in five cases, less extensive changes in eleven, and no pathology in four. Minute hemorrhages were frequently observed. Fragmentation of muscle fibers and disintegration of the muscular substance in the sarcolemmic sheaths, with vacuoles and what appeared to be granular disintegration, were often found. In only one case, that of a seven-year-old child with a widespread superficial streptococcal infection, was there evidence of a septic focus [24] with early, acute inflammatory infiltration in the fibrous tissue between the muscle bundles. Muscular tissue is apparently far more susceptible to intoxication and circulatory changes than to direct bacterial invasion.

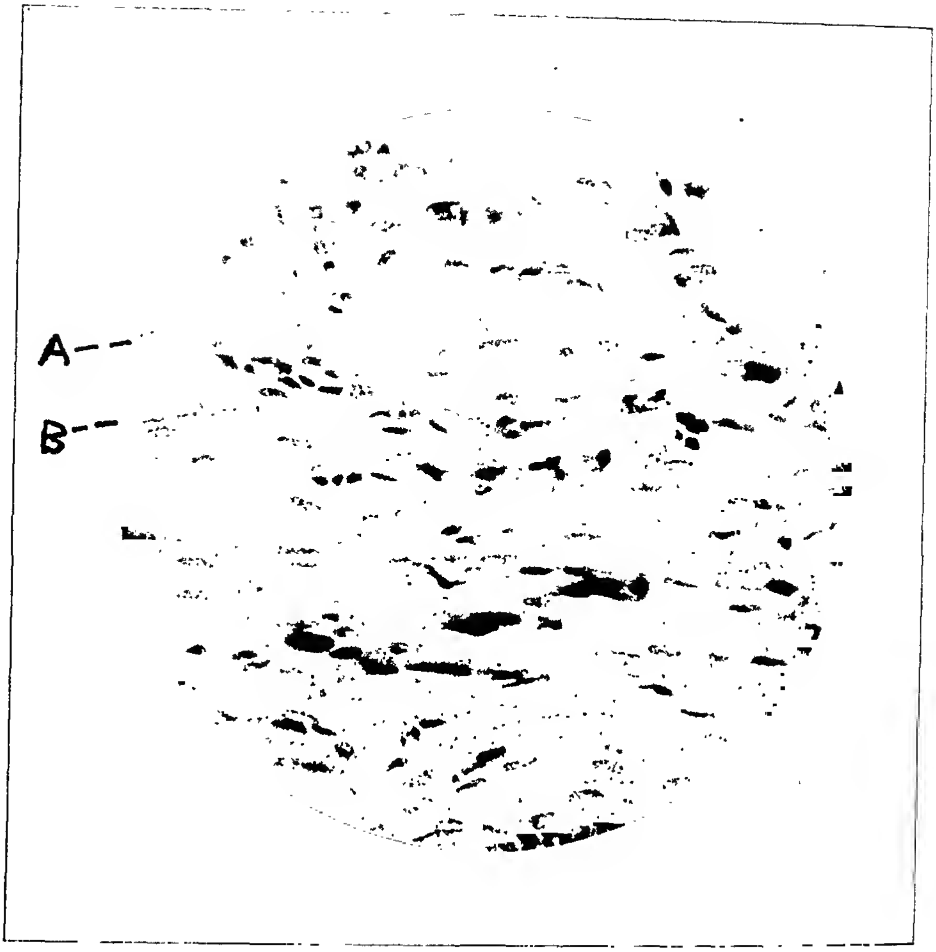

Fig. 1

Photomicrograph of the rectus abdominis muscle (× 350) of a child of three who died from bronchopneumonia. There is extensive hyaline degeneration at *A*. Proliferation of the muscle nuclei about an apparently empty sarcolemmic sheath can be seen at *B*. Phagocytic cells, with darkly staining nuclei, can be observed throughout the section. There are occasional leukocytes. Note the oedema of the remaining muscle fibers and the variability of the staining reaction.

As one would expect, little pathological alteration was found in the muscular tissue of children where death was due to prematurity *per se*. In each of the five cases in which slight pathological changes were found, there was a slight terminal infection, usually of a respiratory nature. Minute hemorrhages between muscle fibers were observed frequently in these cases, some of which were probably the result of birth traumata. In addition to these conditions, localized hyaline degeneration and oedema were the usual findings. No evidence of prematurity of muscular tissue was observed. There is a certain amount of muscular activity during foetal life, and, as far as can be determined, the muscles reach functional maturity during intra-uterine life.

Eleven children in this series died from a nutritional disturbance or a gastro-intestinal infection. Two of these children had bacillary dysentery. There was a complication of tetany in one case, scurvy in another, and

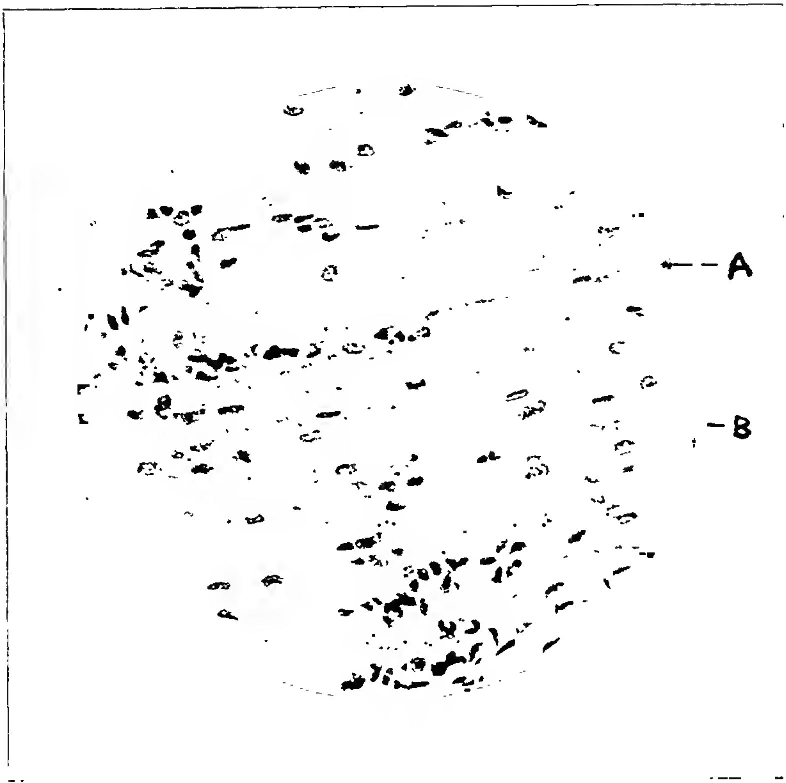

FIG. 2

Photomicrograph of the rectus abdominis muscle (×330) of a child two months old who died from an acute nutritional disturbance. There is slight hyaline degeneration at *A*. Oedema and vacuolation can be seen in the sarcoplasm *B*.

renal rickets in a third. The muscular tissue in seven of these cases showed pathological changes, the most marked of which were found in an eight-year-old child with acute enteritis. The findings differed in no way from those described earlier in this paper (Fig. 2).

In the muscular tissue taken from the six children who died of meningitis, slight hyaline degeneration was observed in three cases. No pathological changes were found in the muscles of four patients who died of tuberculous meningitis.

With the exception of one case, negative findings were also observed in all cases in which death was due to congenital heart disease. In this one case, there were marked oedema of the muscular tissue, minute hemorrhages, and slight hyaline degeneration.

The muscular tissue obtained in five cases of congenital syphilis showed pathological changes. The ages of these children varied between five days and seven months. Hyaline degeneration of the muscles was not observed in any of these cases. The chief pathological finding was an

increase in the perimysial fibrous tissue. There was no evidence of gumma [25].

Noteworthy changes were found in two other patients. One of these, a three-year-old boy, had rhabdomyosarcoma of the urinary bladder, with extensive metastases. The muscles from this patient showed massive infiltration crowding and destroying the muscle cells. There were also many small hemorrhages in the intramuscular septa. The other patient was a boy of ten with tuberculosis of the spine and amyloid disease. There were deposits of amyloid apparently around the muscle cells within the sarcolemmic sheaths. Where the deposits were quite large, complete or partial walling off of the area with fibrous tissue was observed.

DISCUSSION

Many of the pathological changes found in the voluntary muscles of these children were undoubtedly only temporary, and the muscles would have healed entirely if the children had not died. This has been shown by Forbus [26] to be the end result in experimentally produced muscular lesions. The dead muscle tissue is removed by phagocytic cells and new muscle cells are formed by proliferation. Where the damage has been extensive, healing takes place with a certain amount of scar formation. If no regeneration occurs, the muscle is replaced by fibrous tissue.[27] As Brooks [28] has shown, where the circulation of blood and lymph is inadequate, degeneration of a muscle may be followed by complete resorption in seven to twelve days. Bundschuh [29] produced defects in muscles experimentally and observed the various stages of regeneration in which practically normal muscle tissue replaced the defect in ninety-three days. This took place only where the defect was not enlarged during the healing process. Fishback and Fishback [30] produced muscular lesions by various types of injury—chemical, bacterial, and mechanical—and then studied the process of repair. They concluded that, where the injury was slight, as in the case of cloudy swelling, the muscle fibers would probably entirely recover; with greater changes, due to more severe trauma, complete recovery might not occur. If the stroma remained and the sarcolemma was not wholly destroyed, they served as a framework for the remaining muscle nuclei to produce new muscular tissue. Where the damage was extensive, sequestra of muscular tissue might result, as was also reported by Paetzold [31].

If repair of the pathological changes in the muscle occurs promptly, little can be postulated beyond a temporary weakness with slight muscular imbalance. Where repair is delayed or is incomplete, muscular weakness is an inevitable result. Such muscular weakness, whether temporary or permanent, can lead to severe deformity unless the weakened muscles are protected and given proper treatment in order to regain their normal strength and tone. Clinical evidence of such muscular weakness, which may be due in part to disuse and in part to degenerative changes, is seen in the frequent complaint of indefinite pain in the low back and in the legs, particularly during convalescence from a severe illness. It is probably

during this stage, when repair or partial repair is taking place, that these changes in the musculature are of the most importance in the development of scoliosis; and, as clinical evidence attests, a deformity of this type, once started, progresses by well known mechanical laws.

Much has been written on the relation of muscular imbalance to the evolution of scoliosis. Numerous observers have found that scoliosis develops when muscles of the trunk have been cut [32] or have been disturbed functionally on one side of the spine[33]. The importance of weakness in one psoas muscle in the development of scoliosis has been discussed by Krukenberg[34]. Harrenstein [35] in performing autopsies upon children with congenital scoliosis, has observed cases of weakness and faulty development in one of the crura of the diaphragm. Scoliosis, resulting from a defect in the trapezius, has been reported by Schulze-Gocht[36]. The rôle of muscular weakness in producing scoliosis has been fully discussed in recent papers by Carey [37] and by Hauser[38]. Muscular weakness, as a factor in the development of scoliosis, was recognized in 1896 by Brackett [39] who measured the relative strength of the muscles on the two sides of the spine in sixteen cases.

Clinical evidence, as well as the history of many patients with scoliosis, leads us to believe that such unrecognized muscular weakness often acts as the cause of scoliosis. Unfortunately, the child with scoliosis usually comes for treatment only after extensive spinal deformity has occurred, and attempts to determine previous muscular weakness are difficult and uncertain. The number of cases of scoliosis in which the etiology is unknown varies in different clinics, but is admitted by all to be large. How many cases may be the result of muscular weakness, due to pathological changes following disease, we can only conjecture. When the possibility of disturbances in muscle function, following illness in childhood, is recognized and watched for, a step in the prevention of such scoliosis will have been attained. Where weakness of the musculature supporting the spine is found, adequate rest and the support of the spinal column are our most effective therapeutic measures[40].

CONCLUSIONS

In a study of the musculature supporting the spinal column, pathological changes in the muscular tissue were found at autopsy in sixty-three of 100 children who died of the usual diseases of childhood. In most of these cases, complete healing would probably have occurred if the children had recovered. Where complete healing of these pathological changes does not occur, or occurs slowly, the resultant muscular weakness may be the cause of scoliosis.

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ACETABULAR DECOMPENSATION *

BY EDWARD K. CRAVENER, M.D., SCHENECTADY, NEW YORK

The object of this paper is to present a cause of hip-joint pain based upon an infrequent aberrancy of acetabular development. The pure mechanics of this disorder will be outlined.

Development of the Acetabulum:

To clarify our theory, a brief review of the development of the hip socket is necessary. In the new-born child, the acetabulum is composed of two equal parts,—the iliac portion and the ischiopubic portion.[1] As growth proceeds normally the acetabulum comes to be composed of three parts ischium (ischium and pubis) and two parts ilium. In short, the lower portion grows one-third faster than does the upper part (Fig. 5).

Variations in growth rate can produce acetabula of different shapes and sizes. Should the iliac portion lag behind in this relationship, the socket will be shallow. Conversely, if the iliac portion overgrows, the acetabulum will be large and its upper portion oblique. In either case, there will be an inadequate upper margin.

Pathological Anatomy:

The result of this disorder is an insecure hip, occasioned by faulty development.

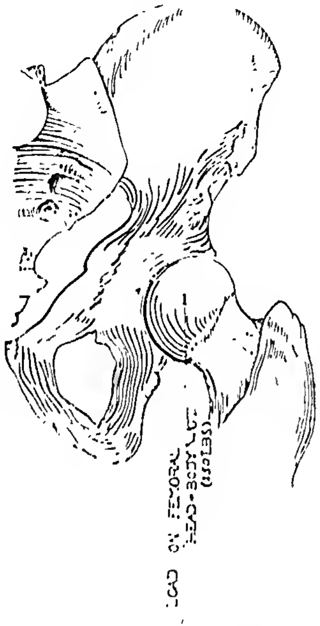
If the acetabulum is large and oblique, part of the weight ordinarily borne by the bone and cartilage of the joint will necessarily be carried on the superior supporting ligaments of the hip. If the acetabulum is small, the result will be the same,—*i.e.*, weight will be borne on structures ill adapted for this purpose. These conditions are shown graphically in Figures 1, 2, 3, and 4. As explained in the captions, engineering principles demonstrate that immense strains are borne on the relatively inadequate hip ligament. This results in bone and calcium deposition in the affected ligaments, which is sufficient evidence of intolerable chronic strain.

Symptoms:

The four cases seen by the author have presented the following symptoms: First, there was an early period with vague, non-radiating pains, localized deep in the hip joint, made worse by exertion and bettered by rest. The pain was usually worse on adduction of the leg; there was no history of real limitation of hip motion. Second, there followed a period with almost constant deep hip pain, made worse by the slightest motion

* Presented by title at the Conference on Rheumatic Diseases, held under the sponsorship of the American Committee for the Control of Rheumatism, New Orleans, Louisiana, May 9, 1932.

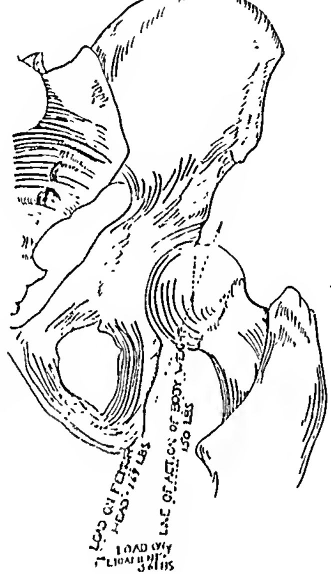
HYPOTHETICAL HIPS WITH PARALLELOGRAMS OF FORCE TO ILLUSTRATE FORCES EXERTED ON THE BONY STRUCTURES AND LIGAMENTS



NO PARALLELOGRAM OF FORCES SINCE ALL WEIGHT IS BORNE IN ACETABULUM

Fig. 1

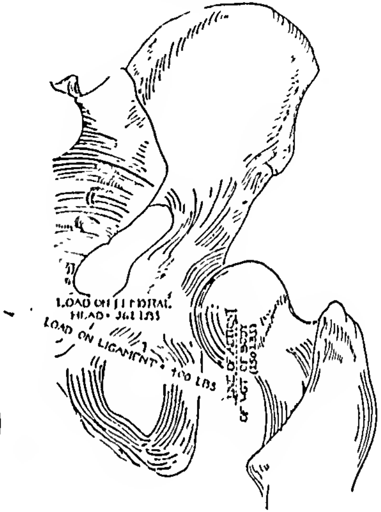
Normal stable hip which bears only weight of body in any position.



PARALLELOGRAM OF FORCES OF 50% ACETABULUM

Fig. 2

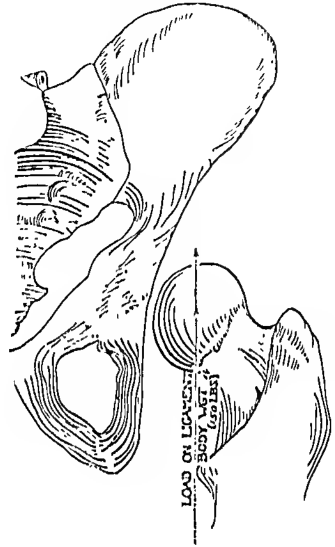
Fifty per cent. acetabulum. This hip is stable in neutral. In twenty degrees' adduction 56 pounds are borne by the ligaments and 160 pounds are borne on the bony structures.



PARALLELOGRAM OF FORCES OF 40% ACETABULUM

Fig. 3

Forty per cent. acetabulum in neutral. Pull of 400 pounds is put on the femoral ligaments. Weight of 362 pounds is borne directly on the acetabulum.



NO PARALLELOGRAM OF FORCES SINCE NO WEIGHT IS BORNE IN ACETABULUM

Fig. 4

Complete dislocation of the hip without an acetabulum. Here the weight of the body, and no more, is borne by ligaments alone.

and only moderately benefited by rest. At this late period in two of the cases the patients complained of pain over the entire leg and thigh, which was not limited to any segmental zone. Two of the patients resorted to crutches in attempts to gain relief. One patient was referred to a tuberculosis sanitarium for treatment.

All four patients, singularly enough all women, gave histories of

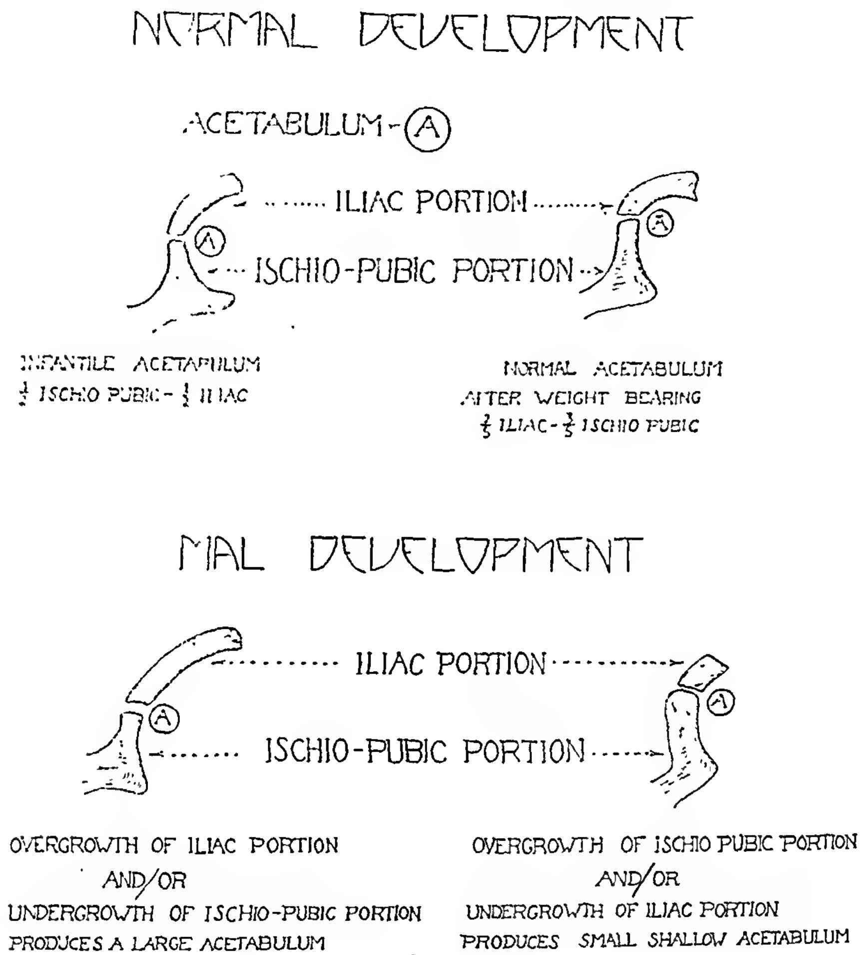


FIG. 5

Upper: To demonstrate growth in properly developed acetabulum. Here, after weight-bearing, the hip socket is composed of two-fifths iliac and three-fifths ischiopubic portions.

Lower: Figure on left shows results of undergrowth of ischiopubic portion. The resultant acetabulum is large and without effective marginal lip.

Right portion of plate shows results of undergrowth of iliac portion. This acetabulum is small and inadequate for a normal femoral head.

sudden gains in weight and reports of slight traumata which preceded their early attacks.

In all four cases, anteroposterior roentgenograms showed either a small acetabulum covering less than half of the femoral head or a very large acetabulum with practically no superior acetabular lip. All of the cases showed calcification in the superior portion of the supporting ligaments of the hip joints.

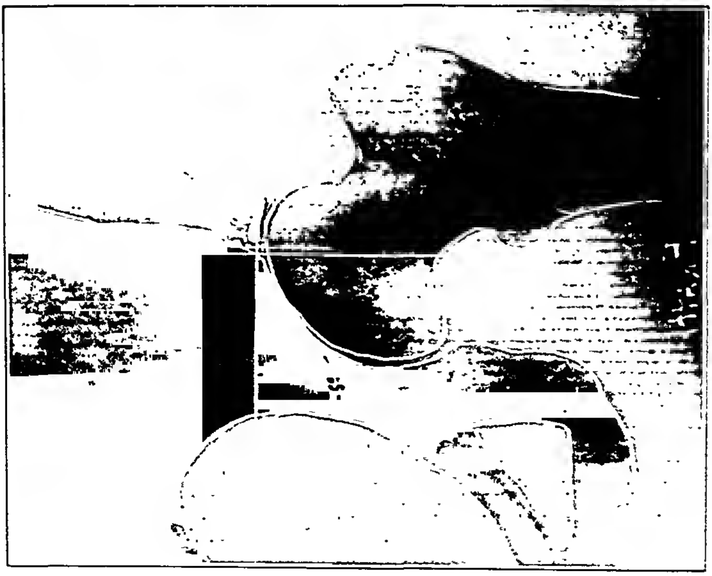


FIG. 6

Case 1. (M. P.) Roentgenogram before operation.

FIG. 7

Case 1. (M. P.) Roentgenogram after operation.

Diagnosis:

In this very short series, diagnosis has been made on a history of hip-joint pain with roentgenographic evidence of an acetabulum, either small and inadequate, or large and oblique.

Differential Diagnosis:

These cases could be considered hypertrophic arthritis in the sense that hypertrophic arthritis is a reaction to intolerable injury. However, since congenital deformities are here present and demonstrable, the writer feels that this is a separate clinical entity.*

Treatment:

This whole disease is evidently based on inadequate support of the body at the hip joint. Therefore, an acetabular shelf, properly placed to supply this deficiency, is indicated. In the three cases (four hips) operated upon, this has been done with symptomatic relief.

Nomenclature:

This condition is called "acetabular decompensation", by the writer, since these hips act exactly as do some congenital disorders of the heart, functioning perfectly until a load or trauma greater than their tolerance forces them into a decompensation.

FIG. 8

Case 2. (A. C.) Roentgenogram before operation.

* Since this concept was developed, an illuminating article by the late Lawrie B. Morrison has appeared in *The American Journal of Roentgenology and Radium Therapy*, (A Study of the Hip Joint from the Standpoint of the Roentgenologist, XXVIII, 484, October 1932) on the possible presence of a separate epiphysis for the acetabular margin. If such an epiphysis exists, it is feasible to regard a percentage of these cases as due to a failure of this epiphysis to unite or develop. The end result is the same; the resultant acetabulum is either too short and small, or presents a sheer incompatible with stability.

CASE REPORTS

CASE 1. M. P. (Hospital No. 99248), female, married, aged twenty-two, presented herself in June 1931, complaining of pain in the left hip dating back to a slight injury two years before. The pain was practically intolerable when attempts at ambulation were made. In fact, certain consultants suspected synovial tuberculosis. The patient was perfectly comfortable in a non-weight-bearing position; there was no muscle spasm about the hip. There was slight increase in abduction with slight diminution of adduction; passive rotation of the hip caused pain in the extreme. A pre-operative roentgenogram is presented in Figure 6.

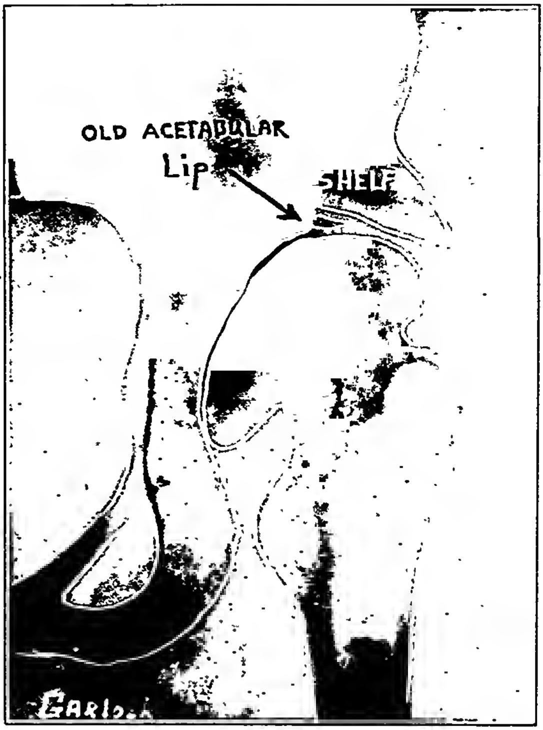


FIG. 9

Case 4. (Dr. E. M. G.) Roentgenogram taken six months after operation. Bony structures outlined with ink for clarity.

On July 29, 1931, a shelf was built over the left hip. After the usual period of necessary rest, weight-bearing was begun. Ten months after operation the patient walked without difficulty or limp. There were no residual effects except a slight limitation of abduction. A postoperative roentgenogram is shown in Figure 7.

Inquiry two years after operation revealed that patient dances two or three times weekly. All motions of the hip are present save the extremes of abduction. There is no pain.

CASE 2. A. C. (Hospital No. 4103), female, single, aged thirty-three, entered the hospital January 14, 1930, complaining of pain in both hips, worse after exertion and bettered by rest. This disability was dated by the patient to a minor fall about three years previously. The disability had become so marked as to incapacitate the patient. There was no peculiarity of gait; no Trendelenburg sign. There was some limitation of motion in the extremes by reason of pain. Physical examination was otherwise negative, except for the presence of several carious teeth. A roentgenogram taken at this time is shown in Figure 8. In February 1930 a shelf was built over the left hip, and two weeks later the same operation was done on the right. Three years after operation the patient walked without difficulty and without pain.

CASE 3. M. S. (Office No. 125-1), female, married, aged sixty-two, complained of pain in the right hip joint of three years' duration. An increase of twenty pounds in weight had occurred about three years previously. Simultaneously pain developed in the right hip, noticeable after exertion. This had gradually increased to total disability.

Roentgenographic examination showed a fifty per cent. acetabulum on the right with hypertrophic change in the iliofemoral ligaments. The motions of the right hip were painful and decreased in the extremes. The left hip was normal in structure.

Operation was refused. The patient was confined to bed for two weeks; the pain completely disappeared, but recurred in full intensity when weight-bearing was resumed.

This patient has been lost trace of and the case is presented only as an example of this disorder. It is interesting to note the long period of latency of this disease. Here, the absence of other hypertrophic changes and the sudden gain in weight would indicate that this is typically a decompensated hip joint.

Case 4. Dr. E. M. G. (Hospital No. 8005), female, single, aged fifty, made a complaint of pain in the left hip of seven years' duration. Early in the disorder (during the first two or three years) pain was present only after exertion. In the last four years pain had been almost constant. Relief was found late at night after rest. There was no radiation of pain.

Physical examination was negative except for a permanent adduction of twenty degrees in the left leg. All motions were present except active and passive abduction. The extremes of motion gave pain. The right hip was completely dislocated and was painless. There was a real shortening of two and one-half inches on the right. The back showed a structural left dorsal, right lumbar curve which produced no symptoms.

In October 1932, after manipulation to reduce the adduction, a shelf was built over the left hip. Nine weeks later the patient returned to her occupation with no hip discomfort.

Follow-up, made ten months after operation, showed slight limitation of passive and active abduction. There was no pain in the hip region.

1. Soutter, Robert, and Lovett, R. W.: Congenital Dislocation of the Hip. A Study of Two Hundred and Seventy-Seven Dislocations. J. Am. Med. Assn., LXXXII, 171, 1924.

MULTIPLE FRACTURES ASSOCIATED WITH BLUE SCLERA

BY EMANUEL B. KAPLAN, M.D., NEW YORK, N. Y.

The nature of multiple fractures associated with blue sclera is obscure. This affliction has been studied by many investigators, and the roentgenographic appearance, pathology, heredity, biochemistry, clinical course, and treatment have been reported in almost every language. Although this condition is known everywhere, many points are awaiting further elucidation.

The purpose of this paper is to add another method of treatment to the long list of therapeutic measures and to investigate the character of the blue discoloration of the eyeball.

In the family of one of the patients observed, it was found that in all the female members the fractures ceased after the normal onset of the menstrual cycle. To verify this observation, a number of cases were studied from the available literature. This study showed that, in a large proportion of females afflicted with multiple fractures, the establishment of a normal menstrual cycle coincided with cessation of the fractures.

It was considered then that, until maturity takes place, the administration of the ovarian hormone to little girls suffering with multiple fractures might bring relief. With this in view, injections of a soluble extract of ovarian substance were given once a week over a certain period. Unfortunately, the treatment could not be continued because one family moved to a different town and the other patient, after a series of twelve injections, refused treatment on account of pain. During the period of injections, no fractures occurred and the patients felt very much better. The frequency of administration was chosen at random. The necessity of the injection method has been felt to be a serious obstacle, because the little patients usually object to repeated injections. The availability of a hormone which could be administered effectively by mouth would facilitate the management of these cases.

The etiology of idiopathic multiple fractures is not known. There might be several distinct types requiring different therapeutic measures. Even the group isolated by Key as a hereditary hypoplasia of the mesenchyma may not be a uniform group. The existence of a definite type, characterized by cessation of fractures in girls after puberty, may be suspected. In cases of this type, the administration of the ovarian hormone may be tried.

In our cases most of the findings of the other authors were confirmed. The biochemistry, heredity, and clinical course were identical to those in the many cases previously reported. One of our patients developed an acute otitis media. The leukocytic response was similar to that of a normal person,—an early high polymorphonuclear leukocytosis, coincident with the onset of infection, subsided gradually with the infection.

In order to investigate the factors responsible for the blue sclera, it was decided to instil a solution of eserine into the eyes of the patients in one series of observations and a solution of atropine in another series. It was thought that, if the blue discoloration were due to increased transparency, the contraction of or dilatation of the vessels of the uvea and tunica choroidea would influence the intensity of the discoloration. The two patients, who were under observation, and the mother of one of them, who also had intense blue sclera, were studied for this purpose. No changes in the discoloration of the sclera were found in either series. The reactions of the pupils were normal. In contrast to these observations, it was found on several occasions that the intensity of the bluish discoloration of the sclera varied without apparent reason.

The results obtained after the instillation of the above mentioned substances were unexpected, as it was believed that, in the case of thinness of the sclera, the action of atropine or eserine on the eye vessels would result in some change in the color of the sclera. Apparently the contention that the color of the sclera is due to an abnormal transparency needs further confirmation.

The following cases were studied at the Hospital for Joint Diseases on the Service of Dr. Harry Finkelstein.

CASE 1. B. G. (No. 38489), a white female, aged six years, was admitted to the Hospital on June 8, 1932, suffering from a fracture of the middle third of the left femur, with posterior and medial angulation.

Past History: Patient was normal at birth, and weighed under six pounds. She was nursed for eleven months and was given viosterol and cod liver oil. At the age of thirteen months, she had a fracture of the left arm, which healed well. At nineteen months, the right leg was accidentally broken. When two and one-half years old, she fell and broke her right arm. All of these fractures healed with more or less deformity. At the age of three years and eight months, she broke her left femur, and suffered a second fracture of the same femur about six months previous to her admission to the Hospital. She had never been seriously ill; dentition was normal. Her sclera were always blue.

Family History: The mother has blue sclera, but has had only one known fracture. The patient's sister, who is at present fifteen years old, has a typical history of multiple fractures. The patient's aunt on the maternal side has blue sclera. She has had no known fractures, although she has suffered from frequent sprains and has bow legs. There were five maternal uncles, four of whom died in infancy and about whom nothing is known; the one living has white sclera and no fractures. The maternal grandmother had blue sclera, and many fractures, and was crippled all her life. The maternal great grandmother had many fractures and was also crippled throughout life; it is not known whether or not she had blue sclera. The mother, the maternal aunt, the grandmother, and the great grandmother were all more or less deaf. The grandmother had two sons,—one was well and the other had typical blue sclera, with multiple fractures, and he was also deaf.

Physical Examination: Examination showed the patient to be undernourished, but very intelligent. Her sclera were blue. She showed multiple deformities involving the upper and lower extremities, a slight kyphosis with a prominence of the lower ribs, an angulation and a genu valgum of the left leg. There was a recent fracture of the middle of the left femur with a posterior angulation. The patient also had an acute right otitis media with a profuse discharge of pus. The muscles showed a normal reaction to electrical excitation. She had a definite hypotonia. The deep reflexes were normal.

Laboratory Studies: Blood examinations on three occasions showed:

Red blood cells	4,480,000	3,358,000	4,200,000
Hemoglobin	65 per cent.	70 per cent.	75 per cent.
White blood cells	14,830	8,300	6,400
Lymphocytes	28 per cent.	36 per cent.	41 per cent.
	Milligrams per 100 cubic centimeters of blood		
Sugar		88.0	
Calcium		10.5	
Phosphorus	5.8	4.7	
Urea nitrogen		472.0	

The Mantoux test was negative. The urine was negative; no Bence-Jones protein was present. Repeated examinations of feces were negative for ova and parasites. Blood Wassermann was negative.

The following is an abstract of an x-ray study made by Dr. M. Pomeranz of the Hospital for Joint Diseases:

The skull shows extreme thinning of all the bones, striae are present. Examination of the spine discloses a moderate kyphosis with a distinct loss in the cancellous detail of all the vertebrae, associated with very pronounced biconcave compressions of most of the dorsal and practically all of the lumbar segments. In the dorsal region, the bodies are reduced to small "wafer-like" densities. In the third, fourth, and fifth lumbar vertebrae, there appeared to be incomplete fractures between the bodies and laminae, as shown in the posterior views. The ribs are extremely atrophic and the trabeculae cannot be distinguished. The pelvis discloses an extreme atrophy of the bones.

The bones of the upper extremities are distinctly underdeveloped in the width of the humeri. The capital epiphysis of the left humerus is atrophic. There is a moderate eccentric atrophy in the shaft with distinct thinning of the cortex, which appears to be somewhat granular externally. In the distal third the trabeculation is extremely coarse. The right humerus shows an identical process, but, at the junction of the middle of the distal third of the shaft, a slight deformity suggests an old fracture at this level. The bones of the right forearm show a distinct underdevelopment of the shafts with eccentric atrophy in the proximal two-thirds. In the distal half the bone is so thinned out that it almost merges with the soft-tissue density. The hands disclose changes which appear to be most marked in the metacarpal bones. The cortices appear to be granular in spots. There are no periosteal changes in the phalanges.

The examination of the bones of the lower extremities shows similar changes. The left femur shows an external angular deformity at the junction of the middle and distal thirds at the site of an old fracture. Approximately one and one-half inches above the epiphyseal line is noticed a complete oblique fracture of the shaft, with a slight callus formation. The shaft proper shows extreme coarseness in trabeculation, with areas in the medulla extremely suggestive of cyst formation. The distal third of the right femur has the appearance of extremely large multiple cysts. There is no evidence of fracture at this level. The bones of the legs show very marked eccentric atrophy in the proximal metaphyses of the tibiae. There is a very distinct granular disintegration of the cortices of the tibiae in the lower metaphyses. In the proximal and distal thirds of the shaft there are evidences of old fractures that healed without deformity. The cortices of most of the metatarsal bones are reduced to "egg-shell" thinness.

In all the bones there is a distinct acceleration in the appearance of the centers of ossification and in the development of the epiphyses.

The extreme granular disintegration, particularly in the tibiae, resembles strikingly the changes which have been described in parathyroid disease.

Adhesive plaster traction was applied and the patient made an uneventful recovery. She was discharged on July 13, 1932, with good union of the fragments.

After discharge from the Hospital, the patient was given injections of one cubic centimeter of soluble extract of ovarian substance once a week for ten weeks. While

receiving the injections, she felt very much better and had no fractures. The injections, however, could not be continued on account of the patient's moving to a different city.

On July 20, 1932, two drops of a 1 to 100 solution of atropine were instilled into the left eye of the patient and the eye was observed at frequent intervals for forty-eight hours. The usual dilatation of the pupil developed, but there was no change in the character and intensity of the blue discoloration of the sclera. Three days later two drops of a 1 to 100 solution of eserine were instilled into the left eye and the patient was examined at frequent intervals for forty-eight hours. No changes were noticed in the color of the sclera.

The sister, mother, and maternal aunt were also examined.

The sister had blue sclera, and a history of multiple fractures beginning at the age of thirteen months. She had her last fracture at eleven years. Her menstruation started when she was twelve years old. She is fifteen years old at present and has had no more fractures. She has an angular deformity of the right elbow and scoliosis of the spine. She is small in stature, but feels well and strong, and is very intelligent. The examination of her blood did not disclose anything abnormal; her blood pressure was normal and the Wassermann reaction was negative.

The mother also has blue sclera. She is small, slightly deaf, and has no visible deformities. Her blood and blood pressure are normal. An examination of the eye, by the instillation of atropine and eserine, similar to that made on her daughter, was done and the results regarding the change of color of the sclera were absolutely negative.

The maternal aunt, who is thirty-five years old, has intense blue sclera, but does not know of any fractures and is not deaf. She is small of stature and has very pronounced bilateral genu varum deformities. Her blood and blood pressure are normal.

Case 2. J. M. (No. 2178), a white female, aged eight years, was admitted to the Hospital in April 1932.

Past History: The patient was delivered with forceps and weighed eight pounds at birth. She developed normally until the age of three and one-half months, when she developed attacks of cyanosis, most of which occurred while she was sleeping. Several physicians thought of a thymus affliction and x-ray treatments were administered. When the baby was six months old, the thymus was pronounced normal. Dentition was normal. The patient was weaned at seven months and subsequently had a well balanced, medically supervised diet. She was always heavy, weighing thirty-seven pounds when seventeen months old. She started to walk at fifteen months. Her first known fracture—a fracture of the left ulna—occurred when she was three years old. At that time, the nature of her affliction was not recognized. Shortly after this fracture healed, she sustained a fracture of the left leg. Between the ages of three and four years, she had altogether six fractures and, within the past year, has had two more fractures. The mother emphasizes the fact that the patient never has had ecchymosis or extensive swelling at the time the fractures have occurred. Multiple examinations of the blood did not reveal anything but a normal picture.

Family History: Both parents seem to be normal. On very close examination, the mother showed a faintly bluish discoloration of the sclera, which she had never noticed. She had always been well and had never had any fractures. No member of the mother's family has ever had any fractures, and no discoloration of the sclera has ever been noticed.

Physical Examination: Examination showed the patient to be well nourished and of normal intelligence. The patient presented the characteristic syndrome of fragilitas ossium with blue sclera. She had a peculiarly shaped head; her neck seemed to be short and the trunk was disproportionately shorter than the upper and lower extremities, giving her an ape-like appearance. She had multiple deformities of the arms and lower extremities, the most noticeable of which were: reversed carrying angle of the left elbow, bilateral genu valgum, and a very marked bilateral planovalgus deformity, more pronounced on the left side. Her reflexes were normal. Her blood histology and chemistry were normal.

To establish the influence of atropine and eserine on the patient's sclera, two series of

observations were made on her left eye. A 1 to 100 solution of eserine was injected into the left eye. Frequent examinations were made within forty-eight hours and no change in the discoloration of the sclera was found. The instillation of a 1 to 100 solution of atropine into the left eye, a few days later, had no visible effect on the sclera.

The patient received a series of twelve injections of the ovarian extract subcutaneously. While receiving the injections, she felt better and had no fractures. However, on November 30, 1932, four months after the last injection, she sustained an oblique fracture of the distal end of the right radius with no displacement. The fracture was treated by immobilization and healed in a very short time. On January 13, 1933, the patient developed a fracture of the distal third of the left tibia. On April 20, 1933, she sustained another fracture of the upper third of the left tibia and the upper extremity of the left fibula. All of these fractures occurred four months after she had received her last injection. This last fracture was treated at the Vanderbilt Clinic, New York City. A short report from the Vanderbilt Clinic showed a normal blood chemistry and an x-ray examination of her skeleton showed the usual changes found in brittle bones.

There are a few salient points in the observation of the cases described which, with the data gathered from the literature, suggest that brittle bones, with blue sclera of the hereditary or spontaneous type, may be due to some endocrine disturbance. The therapeutic response to the ovarian-gland extract in our series of cases, the favorable results obtained by the thymus treatment in the hands of Ryan, the peculiar x-ray appearance of the bones, not unlike that found in parathyroid disease, the early appearance of centers of ossification, and, in our Case 2, the early discovery by competent clinicians of a thymus affliction, seem to favor an endocrine disturbance as a possible explanation of brittle bones.

The hereditary form of brittle bones with blue sclera is at present classified as a hereditary hypoplasia of the mesenchyma. There are a few factors, however, which do not seem to be in full agreement with this generalization.

The formation of callus in fragilitas ossium seems to be normal, or even more pronounced than in a normal case. Although the blood vessels are considered to be brittle, yet, in most of the cases of fragilitas ossium, no ecchymoses are observed. The chemical constitution of the bones, as reported by several observers, is normal. The late appearance of deafness, which is explained by otosclerosis and abnormal calcification of the labyrinthine system, would probably speak against hypoplasia, and the early appearance of centers of ossification would not seem to be an expression of hypoplasia of the mesenchyma.

The nature of brittle bones associated with blue sclera requires further study, which may show whether or not this affliction is really of an endocrine character. In the meantime, it may be advisable to administer some form of ovarian hormone to girls afflicted with this disease before the onset of their normal menstrual cycle.

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HEMATOGENOUS TUBERCULOSIS OF SKELETAL MUSCLE

Report of a Case with Involvement of the Gastrocnemius Muscle

BY W. W. PLUMMER, M.D., S. SANES, M.D., AND
WARREN S. SMITH, M.D., BUFFALO, NEW YORK

From the Orthopaedic Department and Pathological Laboratory, Buffalo General Hospital, and School of Medicine, University of Buffalo

As far as we can determine, the following is the second case of hematogenous (so called primary) tuberculosis of skeletal muscle to appear in the American literature. In addition to its rarity, our case presents these distinctive features:

1. The lesion reached an exceptional size.
2. Clinical observation extended from inception of the disease over a period of two years.
3. Specific etiology was completely proved by pathological and bacteriological studies.
4. The treatment of choice accomplished good symptomatic and functional results.
5. Due to prior history of injury suffered by the patient while at work, medicolegal problems, pertinent to industrial compensation, came up for solution.

REPORT OF CASE

R.S., male, aged twenty years, white, American aircraft mechanic, was admitted on the Service of Dr. Robert P. Dobbie, December 19, 1930, complaining of a swelling in the calf of the left leg, of four weeks' duration. He had always been in good health.

The family history was negative.

In February 1930, while at work, the patient stumbled over an air hose and fell, striking his left knee on a block. Soon after the knee became swollen. For nine weeks treatment consisted of baking and the application of ointments; no splints were used. The patient continued at his work. In April 1930, he was seen by Dr. Dobbie who made a diagnosis of fracture of the outer table of the left patella, which was confirmed by roentgenographic examination. Because of atrophy of the quadriceps muscles, exercise and massage were recommended.

On December 18, 1930 the patient was seen by one of us (W. W. P.), because of a large swelling in the left calf which had first appeared as a nodule three weeks previously and had then grown progressively larger. Pain was present in the region of swelling and radiated downward to the ankle. There was also a constant "tight feeling" in the calf muscles. Locomotion was not impaired. The patient's weight had remained unchanged. Functional inquiry, except for chief complaints, was negative.

Physical examination at the hospital showed the patient to be well developed and well nourished. The chest was clear. Inguinal nodes were palpable. The left thigh muscles showed distinct atrophy. The knee joint was not swollen or painful; mobility was good. The patella, which was free, presented a longitudinal groove in its surface. In the left calf, posteriorly, situated in the upper third of the gastrocnemius muscle, was a mass the size of a goose's egg, apparently well encapsulated, movable, and cystic, but

not fluctuant. The overlying skin was intact, smooth, and normal in temperature. There was no oedema of the left ankle; the veins were not dilated. Reflexes were present and active.

The temperature was 98 to 99 degrees; pulse, 80 to 90; respiration, 20.

Laboratory findings showed: glucose, 111 milligrams per 100 cubic centimeters of blood; urea nitrogen, 9.9 milligrams per 100 cubic centimeters of blood; white blood cells, 9,800 per cubic millimeter; a few scattered white cells were found in the urine; the Kolmer and Kahn tests were negative.

Roentgenograms of the spine, pelvis, femur, left knee joint, tibia, fibula, and ankle revealed no remarkable changes in the bone, periosteum, or joints except for a scar about the left patella,—the result of an old fracture.

During his four days' stay in the hospital, the patient made no special complaints. No oedema of the left leg was noted. No surgical intervention or aspiration was made. The diagnosis at discharge was "cystic" tumor in the left gastrocnemius muscle, nature undetermined.

Shortly after the patient was discharged from the hospital, the mass in the left leg had almost disappeared. The patient returned to work and was not seen again until December 1932. At this time, he gave the history that during the previous two months the swelling had reappeared and had grown rapidly larger, finally reaching such a size as to impede locomotion. Pain was not prominent. Several weeks before this visit, the patient had noticed that the "nodes" in the left groin had increased in size. The patient had lost six pounds in weight.

Upon admission to the hospital in January 1933, physical examination showed flabbiness of the muscles of the left thigh, with atrophy. The left foreleg could be extended fully, but motion was limited in extreme flexion. In the posterior medial aspect of the left calf, situated in the upper third of the gastrocnemius muscle, was an oval mass, the size of a small grapefruit, irregular in contour, but apparently well encapsulated, movable, tense, with firm and soft areas, and not tender to pressure. There was no attachment to skin or bone; no heat or redness. The left calf measured thirty-eight and five-tenths centimeters in circumference; the right calf, thirty-two and five-tenths centimeters.

Fig. 1

Posterior view of lesion in left calf.

Fig. 2

Anterolateral view of lesion.

The lymph nodes in the right groin were just palpable. In the left groin were palpated two tense nodes, the size of a walnut,—one laterally, below the inguinal ligament; and the other, medially, over the pubis. The temperature was 97 to 99 degrees; pulse, 80 to 90; respiration, 20.

Laboratory studies showed: red blood cells 4,400,000; hemoglobin (Tallqvist) 80 per cent.; white blood cells 8,600; polymorphonuclears 64 per cent.; lymphocytes 30 per cent.; monocytes 6 per cent. The tuberculin test was positive; the urine was negative for Bence-Jones protein.

Roentgenographic examination showed the following: *chest*—apices fairly clear, diaphragm regular, hilus shadows of moderate size; *left knee*—patella irregular in outline with exostoses around edges, joint clear, large shadow in the muscles of the calf. The clinical impression was sarcoma or tuberculosis of the muscles of the calf.

The subsequent hospital progress may be outlined chronologically as follows:

January 11, 1933: Left inguinal node was excised. Pathological report: typical fungoid tuberculosis, with large confluent epithelioid tubercles especially in cortex of node.

January 21, 1933: The wound in the left groin was healed.

January 30, 1933: Under avertin-nitrous oxide anaesthesia, an incision was made along the inner aspect of the "tumor" mass. The soleus muscle was split. The mass lay within the continuity of the gastrocnemius muscle (which was split) and possessed a thick wall, enclosing a large amount of curiously fixed gelatinoid material. The thick capsule was intact. The mass had no connection with the tibia or inner hamstring tendons. The wound was closed loosely with two small drainage wicks.

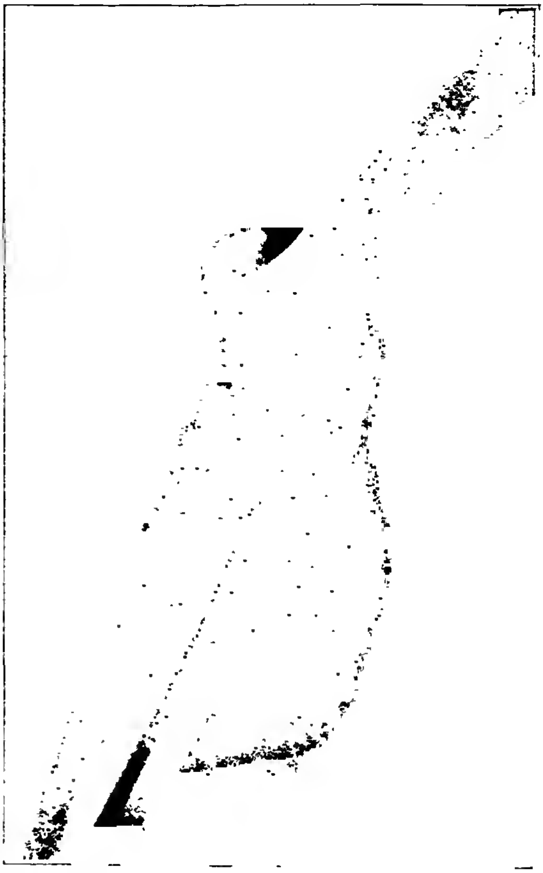

FIG. 3

Roentgenogram showing shadow in soft tissue, old fracture of patella, and normal bone and joint.

Pathological report: Sections from the wall showed typical tuberculosis, with epithelioid and epithelioid-giant-cell tubercles. An isolated structure, resembling tendon, was also present. Bacterial stains revealed no tubercle bacilli.

Bacteriological report: Culture of fresh tissue, ground and digested with sulphuric acid, was negative for tuberculosis. A guinea-pig, injected with digested tissue, gave a positive culture for tuberculosis within eight weeks. Tubercle bacilli were found in the smears and histological sections; culture was positive in twenty-five days. A rabbit,

Fig. 4
Confluent tubercles in cortex of lymph node.

inoculated on January 30, 1933 with ground tissue, was killed on March 25, 1933, and the culture was negative for tuberculosis.

February 20, 1933: There was no drainage; the wound was healed; there was no pain or oedema. Two weeks later, roentgen-ray therapy was begun.

Seven months after discharge from the hospital, the patient had no complaints. There was no recurrence of swelling. The left knee was not swollen. Flexion was not impaired. Extension showed limitation of ten degrees.

COMMENT

Chronic tuberculosis of skeletal muscle is of uncommon occurrence. Culotta[1] in 2,224 autopsies on tuberculous patients discovered only four instances of this disease. Upon an etiological basis, two forms are recognized. In the first (secondary) type, the tuberculous process spreads into the muscle by direct extension from a neighboring structure—*e.g.*, bone, joint, tendon, lymph node, pleura, skin, and mucous membrane[2]. In the second type—which has been variously designated as hematogenous, embolic, metastatic, isolated, and primary tuberculosis of muscle, and which is exceptionally rare—infection is carried into the muscle through the blood stream from a tuberculous focus elsewhere in the body. This condition is not dependent upon acute miliary tuberculosis. The term "primary" can be accurately employed here merely in the sense that, in some instances, the muscle offers either the only demonstrable tuberculous lesion in the body or the most prominent tuberculous lesion.

FIG. 5

Giant-cell and epithelioid-cell tubercles in wall of excised specimen.

Habermaas[3] and Müller[4] are credited with describing in 1886 the first two cases of hematogenous tuberculosis of skeletal muscle. Since then, about fifty-five authentic instances have been recorded chiefly by German, French, and Italian authors[5]. The only case to appear in the American literature up to the present is that of Rugh[6] in 1913. Clairmont, Winterstein, and Dimtza[5] published the last general review on the subject.

From chemical, anatomical, and immunological points of view, several attempts have been made to explain the infrequent incidence of hematogenous tuberculous infection in skeletal muscle. Tria[7] believed that the production of lactic acid prevented infection. Culotta[1], on the other hand, discounted this view and suggested the lack of reticulo-endothelial tissue in muscle as a protective factor. Clairmont, Winterstein, and Dimtza[5] stressed the lack of lymphatic tissue and, also, with Zahnert[8], the abundant blood supply. Von Baumgarten[9] attributed the comparative immunity of muscle to its highly differentiated state. Tubby[10] stated that this immunity "may possibly be due to the presence of antitoxin bodies". The inadequacies of the foregoing anatomical explanations are brought out by the fact that in organs like the liver and the kidney, perhaps equally as highly differentiated and as well vascularized as muscle, and with a similar dearth of lymphatic tissue, hematogenous tuberculous infection often develops.

In 1902 Saltykow[11] studied the pathogenesis of hematogenous tuberculosis of muscle by injecting tubercle bacilli into the femoral arteries of animals. The reaction in the muscles supplied by the artery was noted at varying intervals. The first tuberculous lesions were observed in the intima and walls of the vessels; they then spread into the interstitial tissue. Involvement of the muscle bundles themselves was late and secondary in nature. In 1912 Ely and Cowan[12] buried cultures of bovine tubercle bacilli in the incised leg muscles of rabbits. After different periods of time, the muscles became the seat of a tuberculous process, nodular or caseous in form, which was confined chiefly to the fascia. The tendency to diffuse infiltration of the affected muscle, or extension to neighboring muscles, was not marked. Regional lymph nodes were occasionally affected. Metastatic lesions appeared frequently in the kidneys and lungs. Histologically, muscle fibers adjacent to tuberculous lesions showed degeneration and infiltration to round cells, leukocytes, and eosinophils.

The pathogenie and anatomical findings of tuberculosis of the human muscle coincide closely with the experimental data. Usually a preexistent and distant source (or associated lesion) of tuberculosis can be found in the lungs[13], intestine[2], bone[14], iris[15], and genital organs[13]. In some cases where such a focus cannot be demonstrated, a definite family history of active tuberculosis is obtainable. Clairmont and his associates[5] report a ease of direct inoculation of the muscles of the thigh by autopyotherapy. The essential lesion, which varies in size from a pea to a grapefruit, is situated in the interstitial tissue or along the continuity of the muscle. It may be solitary or multiple, isolated in a single muscle or distributed in several separate muscles. Hematogenous involvement has been described in practically all muscles, especially those belonging to the extremities, the abdomen, and the trunk, such as the supinator longus[6, 16], the triceps[17], the biceps[14], the palmaris longus[18], the flexor digitorum sublimis[19], the extensor digitorum[13], the glutei[20], the quadriceps[4], the rectus femoris[21], the obliquus internus abdominis[22], the pectoralis[20], and the sternocleidomastoid[23, 15].

Hanke[20] distinguishes in general four types: fungoid form, nodule, cold abscess, and sclerosing myositis. The first three types may exist concurrently or they may represent different stages of the same process advancing to necrosis and caseation. In our case, the swelling was first nodular; with softening, and with increasing size, it was converted into a cold abscess. Hanke's fourth type, two examples of which have been studied[24, 25], is characterized by a distinct inflammatory reaction in the interstitial tissue; fibrosis predominates with little tendency to caseation.

Pilliet[26] formulated our knowledge of the histological picture by studying serial sections of diseased muscles. The earliest changes appear in the walls of the vessels and in the interstitial tissue. Tuberculous nodules undergo central necrosis. Cold abscesses, when formed, possess distinct walls. Calcification and fibrosis take place sparingly; extensive

spreading, however, is not the rule. Muscle fibers suffer from compression and simple atrophy. They also manifest different degrees of degeneration,—hyaline, waxy, vacuolar-cellular infiltrative, and hemorrhagic.

Definite bacteriological conclusions cannot be drawn from the literature because of the paucity of complete investigations. In the case cited, tubercle bacilli were isolated by animal inoculation and proved to be of the human group. Müller [4] and Reverdin [14] also demonstrated bacilli.

Sex plays no significant part as a predisposing factor. Adults in the third and fourth decades are most frequently affected. The youngest patients, aged seven and ten years, were reported by de Quervain [23] and Kirmisson [27]; the oldest, aged seventy years, by Kaiser [28]. No instance of this affection has been noted in the negro. Many authors attest to the importance of trauma as an exciting cause.[5, 15, 18, 20, 29, 30]

Hematogenous tuberculosis of the muscle is slow and insidious in its onset. A history of previous or existing tuberculosis in the patient or his family may be present. Swellings, which arise in the muscles and grow slowly but progressively larger, comprise the initial complaint. Because pain is not usually or prominently associated with the swelling, months or years may elapse before a physician is consulted. In the late stages, when the swelling is large in size, muscular movements become limited. The constitutional symptoms occurring inconstantly include slight fever, loss of weight, malaise, and sweating. Physical examination reveals single or multiple masses in one or many muscles, varying in size from a pea to a grapefruit. They seem encapsulated and are ordinarily movable and elastic, but become fixed and hard upon contraction of the muscle. In spots they may be firm, soft, and fluctuant. Pressure elicits tenderness. Communication with the skin, which is usually free, and with the tendons seldom takes place. Regional lymph nodes are rarely involved. The tuberculin test yields positive results. In some cases, there is a slight leukocytosis and monocytosis. In a few instances, material has been aspirated by diagnostic puncture but no bacteria have been disclosed on smears. Habermaas [3], however, found tubercle bacilli.

Clinically, hematogenous tuberculosis of the muscle is most often mistaken for sarcoma. In the differential diagnosis there enter the chronic granulomata (lues, leprosy, actinomycosis), malignant tumors, benign tumors (angioma, lipoma, neurofibroma), and pseudotumors (bursa or tendon cysts, echinococcus cysts, and hematoma). In one case, with involvement of the abdominal muscles, cholecystitis was considered [21]. Before a final diagnosis of hematogenous tuberculosis of skeletal muscle is made, direct extension from a neighboring focus should be ruled out by careful clinical, roentgenographic, operative, and pathological observations.

Although fibrosis and calcification occur to some extent, spontaneous healing in the usual case is not to be anticipated. Except for sclerosing myositis, in which the tendency to fibrosis is notable, the disease is chronic and generally progressive. The eventual prognosis depends upon

the severity of the coexisting tuberculosis, upon the number and the distribution of the muscle lesions, and upon the type and the time of therapeutic intervention. It is well to remember that an isolated tuberculous focus in muscle may become a fruitful source for miliary dissemination in other organs through the blood and lymph routes.

Therapy must be adapted to the type of involvement. Surgical extirpation is indicated in cases showing solitary cold abscesses or a few isolated nodules. Wounds heal by first intention; symptomatic and functional results are good except possibly in cases where the muscle fibers must be cut. Hanke [20] recommends roentgen-ray therapy for the fungoid form, innumerable nodules, and excessive granulations following surgical excision. Puncture of the nodules and abscesses with an injection of ten per cent. iodoform and glycerine has proved of little value. General hygienic measures, including diet, rest, and sunlight, should be prescribed.

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FRACTURES OF THE PATELLA

BY ARTHUR W. ALLEN, M.D., BOSTON, MASSACHUSETTS

From the Fracture Service of the Massachusetts General Hospital

During the period of time allotted to this study, there have been fifty cases of fractured patella in the Massachusetts General Hospital. Of thirty-eight of these cases end results are available; nine, although treated as ward patients, could not be traced; and three were treated in the Emergency Ward and Out-Patient Department only.

Age, Sex Incidence, and Distribution

The youngest patient in this series was twenty years of age, and the oldest, seventy-two years. The age table (Fig. 1) shows that the greatest incidence was in the decade between thirty and forty.

The sex distribution was thirty-four males and sixteen females, or practically twice as many among men as women.

Twenty-five cases involved the right patella; twenty-three, the left; and two were bilateral. It is interesting to note that, in four cases, fractures of the opposite patella had taken place in previous months or years. A fifth patient fractured first the right patella by muscular strain and, within forty-eight hours, fractured the left patella in the same manner.

FRACTURE OF THE PATELLA (38 CASES)
AGE-DISTRIBUTION DECADES

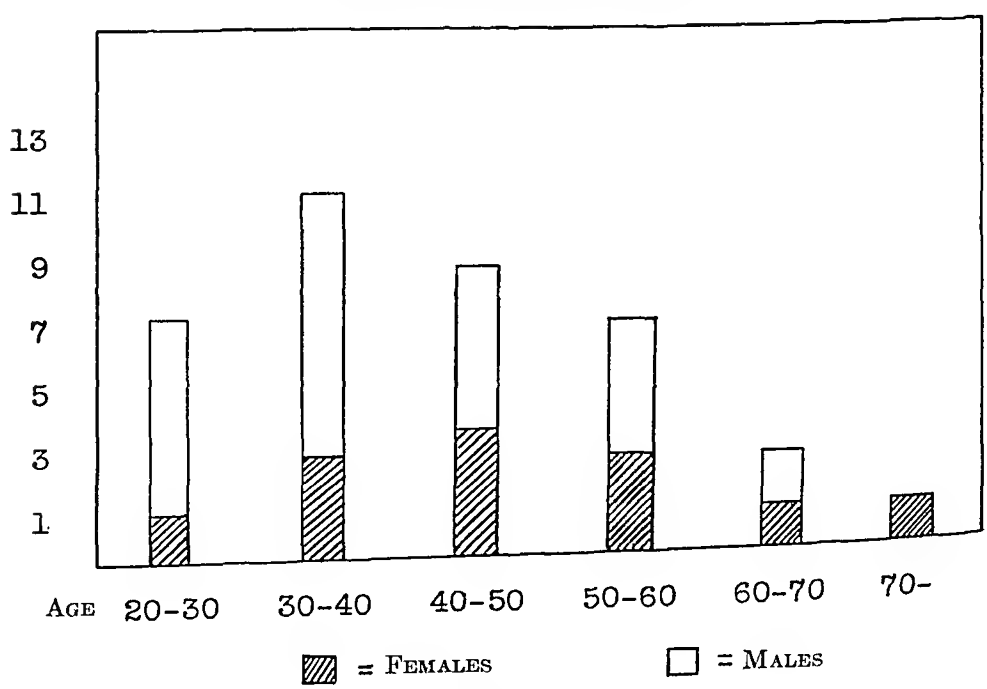

FIG. 1

Since a total of 4066 cases were studied in this entire series, the incidence of fracture of the patella is a fraction over one per cent. (1.229%). Inasmuch as in five of these cases, or ten per cent. of all the patellar injuries, the opposite patella had been fractured at some previous time, it seems that this tendency is more than can be explained on the basis of coincidence alone.

Mechanism of Injury

The mechanism of injury was that of direct trauma in thirty-five cases and of muscular strain only in twelve; it could not be accurately determined in three. Many of the cases of direct trauma were obviously not impact fractures alone, but were a combination of muscular strain with direct injury superimposed; in some instances either force working singly was probably not sufficient to produce the fracture. However, the comminuted fractures and those that were compound were undoubtedly due to direct force primarily.

Occupation

An analysis of the occupations failed to reveal any marked occupational hazard for this particular injury. Almost every walk of life was represented, there being a natural excess of housewives among the women. There were three carpenters in the group.

Type of Fracture

Forty-seven cases were simple fractures; three, compound. Of the former, thirty-four were transverse, one longitudinal, one oblique, and two were chips,—off the lower edge in one instance, and the upper edge in another. Twelve showed no displacement of fragments; the rest were displaced. A few of those that showed little or no displacement were operated upon; but most of these were left to heal spontaneously because the lack of separation indicated a probable absence of extensive tear in the lateral capsular expansion.

Complicating Injuries

In six cases there were present, at the time of admission, other injuries more severe than the fracture of the patella. In two of these there was no displacement of fragments and the patella did not require operation, although the patients required forty-eight and seventy-seven days, respectively, in the hospital for their other injuries. By this time, their fractured patellae were sufficiently healed so as not to prolong disability. Four cases, in spite of severe complicating injuries, had widely separated fragments of the patella, requiring delayed operations. These complicating injuries undoubtedly increased the hospital stay and prolonged disability somewhat.

Method of Treatment

Thirteen cases were treated without operative methods. These were all of individuals in whom the patellar fragments were not widely separated, whose capsules were apparently not torn, or whose complicating injuries prevented any safe surgical approach to the region of the patella. Thirty-seven cases were operated upon. The preoperative stay in the hospital averaged eight and one-half days. This seems a little longer than necessary, but in the average were included many long delays, due to complicating injuries, injured soft parts near the fracture, the patient's general condition, etc. In the uncomplicated transverse fractures, there was less delay and the average time for preparation of the skin, elimination of acute reaction in the joint, etc., was approximately five days.

During this preoperative state, patients were usually kept comfortable in bed with the leg slightly elevated on a pillow and the knee held rigid by straight splints and with ice caps applied about the swollen joint. Forty-eight hours prior to operation the skin was carefully shaved, thoroughly washed with soap and water, followed by alcohol and a sterile dressing. The scrub, alcohol, and sterile dressing were repeated each twelve hours up to the night before operation. In the operating room the skin was prepared by various methods,—usually ether or benzine first, followed by iodine, picric acid, Scott's solution of mercurochrome, or acriflavine, according to the preference of the surgeon. The last named chemical fell into disuse, either justly or unjustly, due to the fact that there seemed to be some difficulty with perfect healing of the skin edges in two or three successive cases in which this drug had been used.

Most of the operations were performed through a long U-shaped incision with the bottom of the U half-way between the tibial tubercle and the lower border of the patella. Occasional cases were done through a longitudinal or an inverted U incision. No difficulty was found with any of the scars, as, regardless of how the incisions were placed, healing took place in such a way that no disability resulted therefrom. It was generally felt that the U-shaped incision gave a better opportunity to expose the entire damaged area, thus making the rent in the lateral capsule easily accessible, as well as having the whole operative field under observation. These scars were less conspicuous than the longitudinal ones due to the more natural cleavage lines, and possibly to a less disturbed blood supply.

TYPES OF REPAIR

It has been borne out for many years that the major feature in a repair of the fractured patella is to reestablish continuity in the great extensor tendon that extends from the thigh to the lower leg, the patella being simply a sesamoid bone placed in this tendon. Therefore, treatment should be based on perfect apposition of the torn fragments of this tendon in such a way as to insure healing, the suturing of the fragments of the patella *per se* being incidental, but of use in the repair, due to their firm attachment to the tendinous structures above and below, and to the

additional security obtained by bony union. It is too much to expect a simple fixation of the fragments of the bony structure alone to properly restore the parts to normal function. It seems, therefore, desirable to approximate the bony fragments accurately and directly by some means or other, as well as to carefully repair the torn capsule, particularly the lateral expansion.

At the Massachusetts General Hospital it had been the practice, for a good many years prior to this study, to rely entirely on a catgut approximation of the capsular tear and a long immobilization of the joint in plaster-of-Paris. This method of treatment gave excellent results in the majority of cases, but in many of them the disability seemed longer than it should have been and there were occasional cases with permanent loss of motion due, undoubtedly, to the long immobilization; also, fibrous union was common.

In 1916 Scudder and Miller[1] reported on the end results in thirty-eight cases of fracture of the patella operated upon by capsular suture in the Massachusetts General Hospital. Ninety-four per cent. of these patients had full extension; sixty and five-tenths per cent. had full flexion; and fifty-seven per cent. had full flexion and extension. Sixty-three per cent. were able to work as well as before injury. Twenty-two cases were examined by x-ray for this end-result study and eighty-one per cent. showed bony union, while in nineteen per cent. absolutely no bony union was present. In some of the latter, however, there were good functional results. They felt, nevertheless, that accurate bony apposition and suture of the lateral expansion with resultant bony union was important. Scudder developed a clamp to hold the fragments together while the sutures were being placed and advocated a purse string of kangaroo tendon about the fragments. Following this study, it was felt that early motion of the joint was desirable, if this could be accomplished without disturbing the accurately apposed fragments. Wire was again

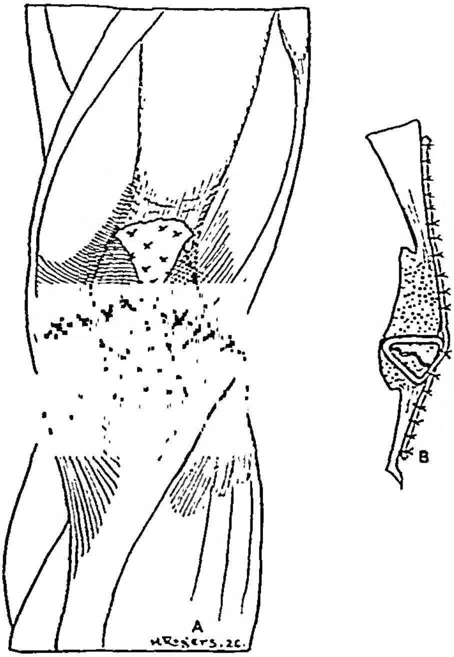

Fig. 2

A illustrates complete fixation of fracture of the patella. The graft can rarely be too long, as the more of it that is sutured to the quadriceps above, and to the prepatellar tendon below, the stronger is the fixation. Note the repair of the lateral extension tear with No. 2 chromic catgut.

B is a lateral diagram of completed fixation. Note the lack of joint penetration. (*By courtesy of Archives of Surgery.*)

tried and found unsatisfactory, either because it would break at an inopportune time or, if the braided bronze variety was used, it offered difficulties in removal should this become necessary. Finally the development of the use of fascia lata in the repair of the fractured patella came about.

Phemister, in 1915, published a method of using a large sheet of fascia lata to bridge the gap of an old fractured patella by suturing the fascia to the quadriceps above and the prepatellar tendon below[2]. This method gave an excellent functional result. A modification of this method in acute fractures of the patella was first advocated and practised by Leland of our Service.

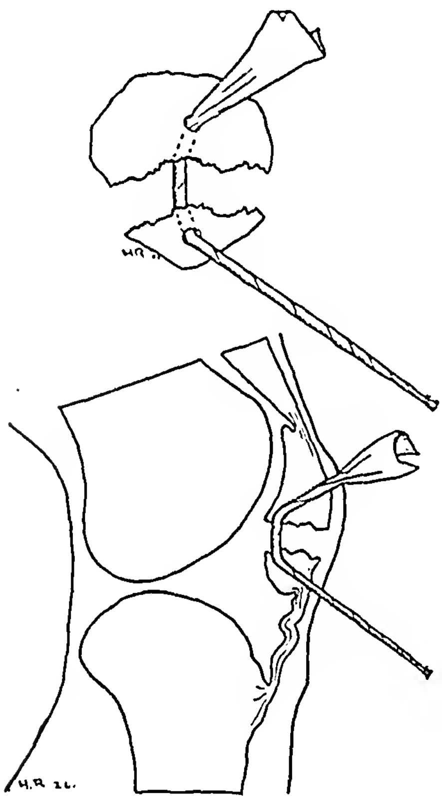

FIG. 3

Method used in fracture of the patella. Note the oblique fenestrations in the fragments. The fascia is three by twenty-four centimeters; the drill, five millimeters. (*By courtesy of Archives of Surgery.*)

Many of us had been using fascia lata for the repair of soft-part defects, as advocated by Gallie and Le Mesurier[3], and had found it extremely satisfactory material. It soon became apparent that its use in the treatment of patella and olecranon fractures was of value; drill holes were used, through which to pass the fascia. Early in 1923, at Wilson's suggestion[4], the writer used a rather large sheet of fascia lata passed through oblique drill holes once, then passed through itself, drawn taut, and the opposite ends sutured to the corresponding ligaments above and below (Figs. 2 and 3). A detailed report of this operation has been recorded [5].

Many modifications of this method can be used, according to the type of the case at hand. Two or three narrower strips can be inserted through smaller drill holes, for use in comminuted fractures of the patella, as advocated by Gallie and Le Mesurier in 1927.[6] Both ends of the fascial transplant can be divided into four or five strands, threaded to large-eyed needles, and sutured directly into the tendinous structures above and below, a modification suggested and used by Marble[7] (Fig. 4). Of course, in the plaque method the fascia lata may be many-tailed and incorporated into the tendon if desired. Some of the advocates of the plaque method drill bony structures and hold the fragments together temporarily by means of kangaroo tendon or heavy catgut (Fig. 5). Leland [8] prefers to use a transplant sufficiently wide to cover part of the lateral expansion suture, as well as the patella, and to suture the graft around its edges only, in an attempt to preserve its elasticity. Almost

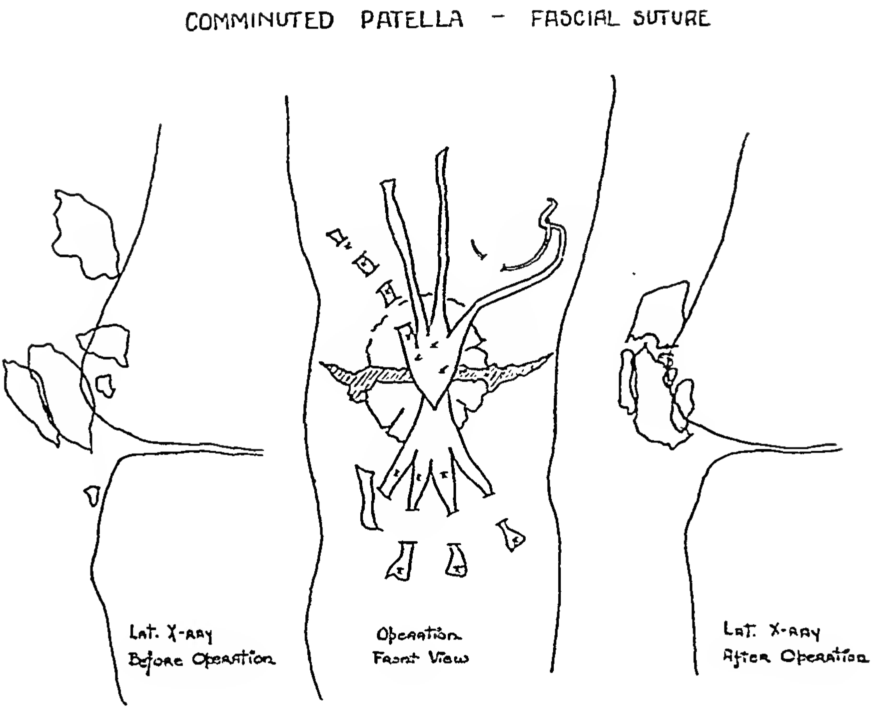

FIG. 4

every member of the Fracture Service has some modification that has satisfied his individual ideas concerning the use of this material. In addition to the cases cited below, well over 100 private cases of fractured patella have been satisfactorily repaired with fascia lata by various members of the Service.

Whatever method is used, it is the opinion of the entire Fracture Service, as evidenced by the following data, that fascia lata should be used intelligently in the repair of the average fracture of the patella. Most of us feel that there is some advantage in taking the material from the opposite thigh, inasmuch as early motion, which this method permits, is highly desirable to early return of function.

It was found that in the thirty-seven operative cases of this series, kangaroo tendon was used twice, and catgut was used four times. In five cases, fragments were drilled and held with kangaroo tendon over which a large plaque of fascia lata was placed. In ten cases, fascia-lata transplants were used and the bone not drilled. The repair was accomplished in fifteen instances by fascia lata being passed through drill holes in the fragments. It may be well to reiterate that, whatever type of fixation or support was used to the bone itself, the rent in the lateral capsular expansion was carefully repaired, usually with interrupted sutures of chromic catgut, but sometimes with strands of fascia lata instead.

AFTER-CARE

It is well to splint the joint with a plaster shell for twenty-four hours, particularly if the patient has had ether anaesthesia, after which no splint is necessary while the patient is in bed. Active motion is started at the end of seventy-two hours as a rule, in some cases a day earlier and in some a day or two later, depending on the general reaction, etc. Motion can be started somewhat earlier, with comfort, if the fascia-lata grafts have been taken from the opposite thigh. Passive motion should never be used. It is frequently necessary to assist the patient in his first attempts at motion. The amount of motion carried out each day is restricted to the limits of discomfort, and is gradually increased.

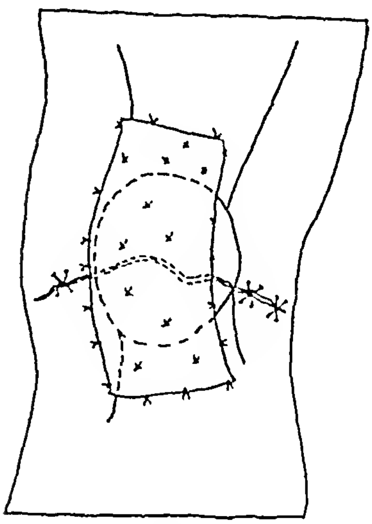

FIG. 5-A

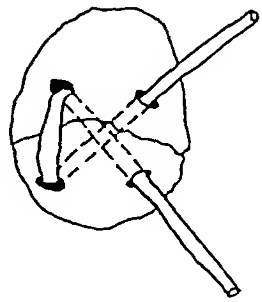

FIG. 5-B

Fig. 5-A. Illustrating a combination of suturing the lateral expansion and reinforcing the quadriceps and prepatellar tendons with a plaque of fascia.

Fig. 5-B. Small drill holes may be placed through the fragments of the patella, which is first fixed with kangaroo tendon over which a plaque of fascia may be used.

In some timid patients the leg may be suspended to advantage in a Thomas splint with a Pierson attachment. The patient is allowed out of bed in a week. Weight-bearing can usually be started at the end of two weeks. It is well to support the leg on a posterior splint when the patient is first out of bed, and crutches should be used until the patient has thoroughly regained his equilibrium. Usually both supports can be safely discarded after the fourth week. Complete motion is expected within twelve weeks from injury, and in the majority of uncomplicated cases the patients should be able to resume their usual occupations shortly thereafter.

The average number of days in the hospital was forty per person. The period, of course, was somewhat shorter in the uncomplicated simple transverse fractures of the patella, but this average includes all of the complicated cases. The average time until return to work for the entire group was twenty-four weeks,—this is in spite of compensation laws, which undoubtedly caused prolonged absence from work in a great many instances, and of complicating injuries in other cases. On the other hand, this is fairly well offset by the fact that a certain number of housewives returned to their duties shortly after their return home from the hospital.

Complications—Postoperative

There was one death on the operating table (in Case 6), thought to be due to a cerebral accident of some sort; it is difficult to explain. It was a medicolegal case and no autopsy was performed. One wonders about fat emboli or the possibility of death from the anaesthetic.

There were two small hematomata in the wounds and two cases of minor sepsis. None of these four complications prolonged disability. There were also two cases of fairly severe upper respiratory infection. There was one case (Case 28) of refracture of the patella three months after the first injury. The repaired capsule had been reinforced by a fascia-lata plaque, the patellar fragments had not been drilled, the patient was uncooperative and had regained very little motion at the time of her second injury which, however, was sufficiently severe to have produced a fracture had there been no previous separation. The second repair was accomplished by kangaroo tendon through drill holes and a plaque of fascia lata over the suture line. The final result was perfect, although the patient had a total disability of one year.

END RESULTS

The summary of the end results showed that twenty-eight out of thirty-eight cases were granted a perfect score of A^4 F^4 E^4. Thirty-four had perfect economic results; thirty-two had perfect functional results; and thirty had perfect anatomical results. Five cases were graded 3 anatomically; three cases were graded 3 functionally; and one case was graded 3 economically. There was no incidence of any case studied being graded below 3.

In twenty-four cases out of the thirty-eight on which end results were available, definite mention of the type of union was made. Twenty-two of these were said to have bony or solid union and two fibrous union. Inasmuch as the anatomical grading was made on the basis of bony union and accurate apposition of fragments, it is fair to assume that in all of the thirty cases graded 4 anatomically, bony union was present. In addition, Case 8, Case 20, and Case 31 were graded 3 anatomically, but definite statements were made that there was bony union.

The two cases of fibrous union are interesting. Case 1 was a compound fracture operated upon fifty-three days after injury. Kangaroo tendon was used through drill holes to hold the fragments in apposition, the capsule was sutured, and a plaque of fascia lata was placed over the patella. This is the only case in which fascia was used where bony union failed to take place. Case 14, recorded as fibrous union, had only a capsular suture with catgut and kangaroo tendon. This case was complicated by a fracture of the tibia on the same side.

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ADOLESCENT OSTEOCHONDRITIS OF THE SYMPHYSIS PUBIS

With a Consideration of the Normal Roentgenographic Changes in the Symphysis Pubis

BY MICHAEL BURMAN, M.D., ISAAC NEWTON WEINKLE, M.D., AND MAURICE J. LANGSAM, M.D., NEW YORK, N. Y.

Disease processes seldom involve the symphysis pubis, and, of those that do, only traumatic diastasis of the symphysis has been adequately described. Tuberculosis or osteomyelitis are rarely seen. Occasionally after a suprapubic cystotomy, a suppurative osteochondritis—osteomyelitis to all intents—may develop. The region of the symphysis is also occasionally involved in tumor metastasis, but the symphysis itself seems to be spared.

The case which is being reported is unique in that no record of a similar condition has apparently been published. It also is important because of its medicolegal significance.

CASE REPORT

A young man, seventeen years of age, while working on a construction job, August 15, 1932, was pinned between a slowly moving auto truck and a fence. Most of the contact was made with the lower part of his abdomen; his more than usual height prevented any contact higher up. The time of contact was brief, probably not exceeding one minute. He at once complained of severe pain in his abdomen and was sent home and put to bed. One of us (M. B.) saw him the next day at his home, when the pain, which was definitely present over the region of the symphysis pubis and still radiated to each groin and down the inner side of each thigh, had gradually become duller. He was never unconscious, nor did he vomit. However, he had experienced some nausea. There was no difficulty in urination and defecation, and no passage of blood in either urine or stool.

On examination, it was ascertained that no tenderness was present in the bony parts of the symphysis pubis, but that all tenderness and pain were confined to the muscles, especially over the lowest part of the right rectus abdominis and pyramidalis muscles. The left side was much less tender. No muscular spasm or rigidity were present, and the abdomen was soft and not tender. On tensing the abdominal muscles by assuming the sitting position from the lying position, it was made very definite that all tenderness was muscular. No swelling and no ecchymosis were seen. A urine examination was negative for blood.

Rest in bed, with an ice bag to the lower abdomen, was advised. Although it was urged, a roentgenogram was not taken because of financial reasons. A diagnosis of contusion of the lowest part of both the rectus and the pyramidalis muscles was made.

That this diagnosis was correct was borne out by the fact that on September 7 he was entirely symptom-free and had been so for a week. He was allowed full freedom of activity, but was cautioned about overdoing in athletics, especially football.

On October 25, he was seen again and was still symptom-free. Examination of the region of the symphysis pubis was entirely negative.

On December 26, four months and eleven days after his original injury, he returned

Fig. 1

Roentgenogram, taken four and one-half months after injury, showing the wooliness and the fragmentation of the symphysis pubis.

Fig. 2

Roentgenogram, taken about nine and one-half months after initial trauma, showing almost complete subsidence of the disease process within the symphysis pubis. The symphysis is, however, definitely irregular.

again. He had experienced a dull, dragging pain in the region of the symphysis pubis for a week. This pain radiated up the abdomen, down the inner side of the thighs, and across to each groin. He had been rowing for the past few months in an effort to make the school team. Otherwise, no trauma was known and the pain seemed to have arisen spontaneously. He walked perfectly normally. No other symptoms were present.

On examination, it was found that all tenderness was now bony, and not muscular at all. Pain was very marked over the right pubic bone, just lateral to the symphysis pubis, and extended from its superior to its inferior borders. Pain was also present over the left half of the symphysis pubis and over the symphysis itself, but to a lesser degree. There were no swelling, abscess, or sinus opening, and no signs of recent injury. The patient did not complain of backache, nor was there tenderness at any point in his back. That backache may be present in disease of the symphysis pubis, even long before attention is directed to the symphysis pubis, is a fact that should not be forgotten. This is so by virtue of the fact that the symphysis pubis is a fulcrum in the ring of the pelvis.

A secondary disease process had evidently appeared in the symphysis pubis, following an initial trauma four and one-half months previously. A preroentgenographic diagnosis of adolescent osteochondritis of the symphysis pubis was made. The disease seemed analogous to those other disease processes of growth encountered secondarily.

A roentgenogram (Fig. 1), taken a few days later, showed an irregular, woolly appearance of the symphysis pubis, with an excess of the mammillation noted in many symphyses at this particular period. There were several free bone fragments in the space of the symphysis itself. The process seemed more advanced on the right side. The epiphysis of the tuberosity of the ischium was noted as unaltered. A phlebolith was present over the ascending ramus of the left pubic bone. The hip joints and the sacro-iliac joints were negative.

Fig. 3

Roentgenogram, fifteen months after initial trauma.

The patient was given baking and massage treatments over the affected region three times a week. A polo belt, to fix the symphysis pubis, was ordered. After each treatment, the patient complained of a temporary exacerbation of pain which lasted several hours.

By January 11, 1933, the symptoms were greatly lessened. Tenderness was present only in the superior and medial aspects of the right half of the symphysis pubis. A rectal examination elicited no pain in the pubic bones.

On January 25, he had had no pain objectively or subjectively for over a week.

On January 28, he was admitted to the Hospital for Joint Diseases for one day. A quantitative tuberculin test, a blood Wassermann, a routine urine examination, and a blood count were made; and, finally, a stereoroentgenogram of the symphysis pubis was taken. The various laboratory tests were all negative. In clinching the diagnosis, it was considered quite important to have a stereoroentgenogram taken, since overlapping shadows and the shadows of soft tissues within the pelvis and gas and feces within the bowels render a flat plate of the symphysis pubis difficult to interpret. The stereoroentgenogram showed an advance in the disease process, although clinically it had sub-

sided. The disease process was greater on the right side, and the fragmentation and woolly appearance of the symphysis pubis were very nicely demonstrated.

In an effort to stimulate the blood supply to the area, treatments were resumed on February 11. These were kept up until March 4, at which time the patient was still symptomless, both subjectively and objectively.

On June 1, another flat roentgenogram (Fig. 2) was taken. At this time, there was almost complete subsidence of the disease process; the line of the symphysis pubis was almost smooth, and the irregularity suggested only slightly the previous woolly appearance. A questionable free fragment was still present in the left superomedial aspect of the symphysis pubis. The shadow of the phlebolith was still noted.

A final roentgenogram, taken November 24, 1933 (Fig. 3), showed that the disease process had almost spent itself, although the symphysis was still somewhat more irregular than is usual. This was more marked on the right side, and the upper half of the right pubic bone showed an incomplete dissecting process, outlining a denser shadow which might be the site of a future free bone fragment.

The patient was symptom-free, and an examination of the pubis was negative.

COMMENT

In looking over the literature on alterations in the symphysis pubis, it was quickly found that little had been written on the normal roentgenographic appearance of the symphysis pubis. For the appreciation of this case, it was decided that a study of the normal symphysis pubis, especially that of the second decade, would form a basis for the consideration of this

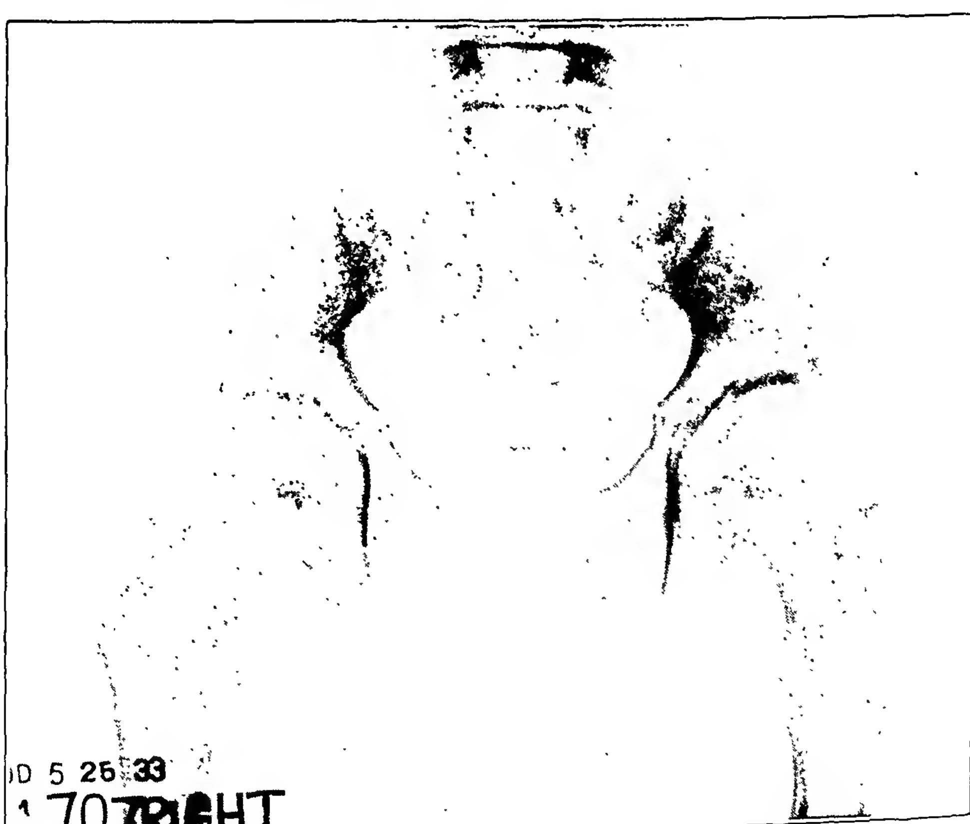

FIG. 4

Roentgenogram showing the symphysis pubis of a young girl aged ten years. A questionable fragmentation of the upper edge of the right pubic bone is seen. The persistence of the pea-sized swelling at the ischiopubic junction is noted.

TABLE I

STUDY OF 127 ROENTGENOGRAMS OF THE SYMPHYSIS PUBIS

Ages of Patients (Decades)	No. of Roentgenograms Examined	Male	Female
0–9 years inclusive	24	9	15
10–19 years inclusive	29	14	15
20–29 years inclusive	16	5	11
30–39 years inclusive	15	8	7
40–49 years inclusive	17	6	11
50–59 years inclusive	18	10	8
60–69 years inclusive	7	3	4
70–79 years inclusive	1	0	1
	127	55	72

heretofore undescribed condition. Therefore, a study was made of 127 roentgenograms of the symphysis pubis. A larger number could have been studied, but sufficient information was obtained from these 127 roentgenograms to explain this condition.

NORMAL ROENTGENOGRAPHIC APPEARANCE OF THE SYMPHYSIS PUBIS

The symphysis pubis of the very young is broad, flaring outward above and below. There is no suggestion of mammillation. The ischio-pubic junction does not join until the age of four, and the site of junction is represented by a spherical swelling the size of a cherry pit. This swelling may show two or three areas of vacuolation, each bordered by a line of condensation. This is normal and is not indicative of osteochondritis. The site of junction may also be V-shaped, the arm of the pubis fitting into the groove of the ischium. Full union takes place at about the age of seven, but may be delayed in certain conditions, as in congenital dislocation of the hip. From the tenth year on, the symphysis pubis often shows horizontal grooving or mammillation, which is more manifest in the earlier years of the second decade. Todd has compared this undulating line of cartilage over bone to an epiphysis over a diaphysis. Lang and Haslhofer have shown that, at points of not infrequent mucoid and oedematous degeneration of the cartilage, an indentation occurs which is smoothed over ultimately by progressive ossification. This appearance of the symphysis pubis is detected in roentgenograms taken over a period of years, but is usually most marked between the ages of twelve and fourteen.

In two cases there was a seeming fragmentation of the symphysis pubis, somewhat comparable to that seen in our case. No symptoms were referable to the symphysis pubis, and, since the plates were not stereoscopic, it was not possible to rule out extraneous shadows.

Toward the age of twenty, the edges of the symphysis pubis become smooth, are more vertically placed, and approach the adult type. In the

Fig. 5

Roentgenogram showing the normal symphysis pubis of a boy of fourteen years. Note the normal grooving or mammillation of the symphysis. A growth disturbance in this type of symphysis is believed to have caused the unusual changes observed in our case.

third decade, the symphysis pubis is more or less vertically placed, with straight and sometimes concavoconvex edges. It is narrow, its width being about one-eighth of an inch. Some sclerosis of the edges is noted, indicating increasing ossification of the cartilaginous face. Mammillation, or grooving, is no longer seen. One case in the third decade showed a pregnancy diastasis of the symphysis pubis, of moderate degree, with some bony fragmentation within the symphysis. This adult type of symphysis pubis, seen in the third decade, is also noted from the ages of thirty to forty-five. From forty-five to sixty years of age, the typical configuration of the symphysis pubis is still

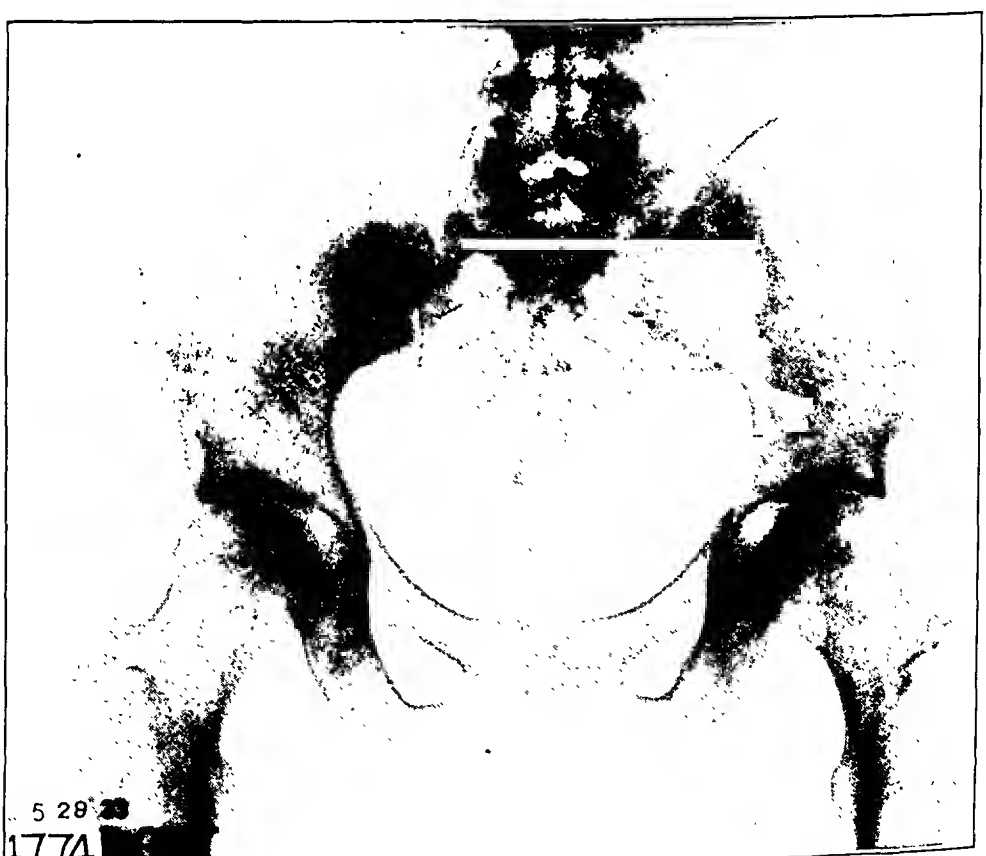

Fig. 6

Roentgenogram of the normal symphysis pubis of a young man, aged twenty-one.

unaltered; however, the edges of the symphysis may be more sclerotic than normal, and the interspace may be reduced to less than one-eighth of an inch. Simple arthritic spurring is seen superiorly, and ossification is very seldom noted in the inferior arcuate ligament. In one case, a gouging out of one face of the symphysis pubis, with a free bone fragment in the interspace, was seen in a symptomless symphysis pubis. In another, a double gouging out at the same level of the symphysis pubis, without bony fragmentation, was seen.

From sixty to seventy-five years of age, an increase of the lipping, narrowing, and sclerosis is observed, although never of an advanced degree. In one case, excavation of the superior border, with bony fragmentation, was present; in two cases, the pubic bones were involved in metastatic processes, but the symphysis pubis itself was spared. The authors have not seen a synostosis of the symphysis pubis.

It is with uncertainty that one differentiates between the male symphysis pubis and that of the female. The acuteness of the male pubic angle and the greater height and possibly narrower interspace of the masculine symphysis pubis are not distinctive enough features to warrant determination of sex with certainty.

Accurate roentgenographic estimate of the symphysis pubis is made more difficult by the presence of shadows extraneous to the pubis, but

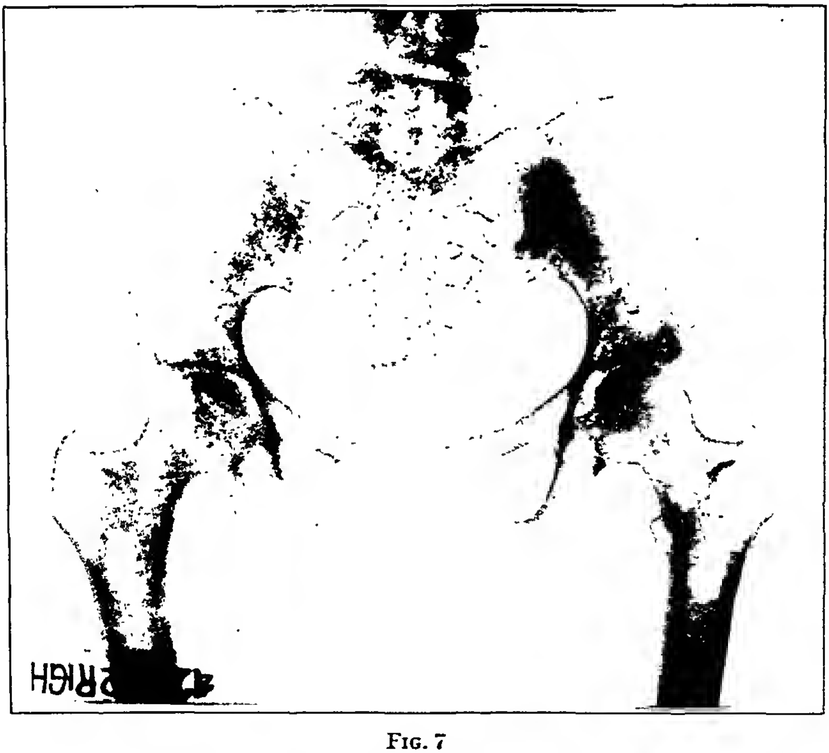

FIG. 7

Roentgenogram showing mild pregnancy diastasis of the symphysis pubis of a woman aged twenty-three. Slight bony fragmentation within the interspace.

which apparently lie within it. The most common of these are the presence of phleboliths in the pelvic veins and the overlapping shadows of the coccyx and of gas and feces within the bowels. The superior angle of the symphysis pubis, which is usually not sharply outlined, may seem to be the seat of areas of rarefaction, of increased density, or of fragmentation. A whole host of other more easily differentiated shadows is tabulated by Köhler. Again, certain normal areas of rarefaction in pubic bones have been pointed out by Heeren, indicating that the pubic bones are not of uniform density throughout. To avoid confusion, stereoscopic roentgenography of the symphysis pubis should be done in any case requiring special examination of that region; grave errors can thus be avoided.

Fig. 8

Roentgenogram showing the symphysis pubis of a woman of forty-eight years, who presented no local symptoms or signs. Gouging out of one face of the symphysis pubis is seen, with bony fragment in interspace.

We have had no experience with the changes in the symphysis pubis in pregnancy. One group contends that diastasis does not occur, while another notes it frequently. Anatomically, gross and microscopic changes of fissuring, hemorrhage, cysts with cartilaginous bodies therein, and microscopic fractures have been reported by several authors. These changes are noted almost uniformly during pregnancy and regress after delivery, so that no trace of them is found a year or more later.

These anatomical changes undoubtedly predispose to pregnancy diastasis. They may not be roentgenographically visible. Thus Reis, Baer, Arens, and Stewart contend that no roentgenographic changes have been noted in any patient of their series at any time during pregnancy or thereafter.

Diastasis may be noted in infections of the symphysis pubis. The separation may develop fairly rapidly in acute osteomyelitis. The senior author has had an opportunity to observe a less rapid diastasis in one of his patients with tuberculous osteomyelitis of the symphysis pubis.

The anatomical changes in the symphysis pubis as age progresses are now being investigated by Dr. Charles Sutro. This study should establish an anatomical basis for the roentgenographic changes noted in the various decade groups, and for the particular changes observed in pregnancy. The effect of suppurative processes upon the fibrocartilage of the symphysis pubis should also be studied experimentally.

The understanding of the case here reported depends upon the appreciation of the presence of the normal grooving or mammillation of the symphysis pubis in the second decade.

The changes in the symphysis pubis of our patient were undoubtedly due to a growth disturbance at a period in which ossification was active but incomplete. The original trauma probably injured the blood supply to the symphysis pubis.

The pathological changes can be inferred to be an aseptic, subchondral necrosis, comparable to the pathological changes observed in other osteochondritides, although this inference is open to criticism since no specimen is available. Many unrecognized cases, asymptomatic as well as symptomatic, must occur. The condition is definitely benign, and clinical recovery is fairly rapid. Roentgenographically, however, the symphysis pubis heals in such a manner that there is more irregularity of the symphysis than is usual.

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PHYSIOTHERAPY IN FRACTURE TREATMENT

BY FREDERIC JAY COTTON, M.D., F.A.C.S., AND
THOMAS HOWARD PETERSON, M.D., BOSTON, MASSACHUSETTS

Physiotherapy should have, as it has not had in the past, a very important rôle in the treatment of injuries, particularly fractures.

That it has not played such a rôle is in part due to ignorance or indolence on the part of the surgeon, in part to extravagant and illogical claims as to what can be accomplished.

In fact, unfortunately, one commonly hears *all* physiotherapy for fractures condemned, and swept aside by the surgeons into one waste basket with the much abused "B. & M."—baking and massage.

So it is that, so far as fractures go, physiotherapy seems to have fallen upon evil days, suffering, as so many things are, from depression following undue expansion.

And this boom, like others, had its rise in enthusiasms, not logical thought and study.

But physiotherapy rightly used is of the greatest value in fracture work.

Only, we have to know something about using it.

And, first, what is physiotherapy?

A good definition is hard to formulate.

It means the application in medical practice of physical means other than medicaments (and foods) or surgical procedures.

This is a large classification, but perhaps essentially correct.

Early physiotherapy was massage.

From early history—in prescriptural times—man has believed in the efficacy, in disease and injury, of the "laying on of hands", whether that might mean the blessing of "the King's touch" or the more intimate and heavy-handed ministrations of the rubber or masseur.

Also, incradicable is the belief of all of us in the "rubbing in" of liniments, lotions, and salves.

Only the strong-minded can go so far as really to believe that it is only the rubbing that matters—and that that doesn't matter very much.

Almost as firmly implanted is the belief in electricity as such, and it probably never will be possible really to impart to the public the conviction that electricity—the current *as such*—introduced into the human body, has never been shown to be of the slightest use.

The sensory and psychic effects remain, and in this direction the use of the various currents may have some excuse—and even reason.

But surely nearly, if not quite, all electrotherapy is suggestion, delusional, not directly therapeutic.

Passive exercises, with or without stretching, used from time immemorial, are really of very limited value, but have only lately been sup-

planted, and only in part at that, by active exercises, which form far and away the most important item in fracture treatment by physiotherapy.

This includes, of course, both ordinary active movements and movements in which the weight of the limb is supported by the hand of the operator or in a supporting medium, be it water or the paraffin bath. There is a definite distinction between active supported exercise and non-supported exercise of the usual type.

Heat, obviously comforting, has unquestioned value, but is less important than is believed, in treatment of injuries at least. Its main function is in preparation for exercises, and its action is pleasantly sedative to pain, sedative to spasm, stimulating in the sense of promoting some hyperaemia. It is applied in many ways.

But lately we have had advocated, not only baking lights for heat, but lights of all sorts and all wave lengths, each, according to its prospectus, adapted to the accomplishing of some special purpose,—marvellously efficient.

Probably it all comes to this,—all lights give heat, penetrating more or less, never penetrating very far. Beyond this, sunlight direct, or sunlight transmitted through quartz, gives the full range of the spectrum, and quartz-mercury-vapor lamps, as such, give certain rays, particularly ultraviolet of medium wave length, effective as the vitamins are effective (particularly vitamin D) in promoting metabolism, and in laying down calcium. This sort of light therapy may promote fracture repair by way of rendering blood calcium available. It has nothing to do directly with promoting return of function in joint or muscle, since the chemical changes occur in the blood in or just beneath the skin only, as far as is known.

Now it may be of service to run over very briefly the various "modalities", so called, of electrical methods andthe variety of lights, before going on to what we believe are the most important things we can do to promote fracture repair and the return of use to the limb.

Static electricity has probably no more value than that of pleasant titillation, and the effects of the technical scenery of the surroundings.

The *galvanic* current has testing value, is not reliably available for muscle work, and has not been shown of use in promoting absorption or repair.

Faradic current direct may be disposed of in the same phrase.

Interrupted sinusoidal currents have value particularly for muscle stimulation,—sometimes very important.

The difficulty has been that with muscle function artificially induced has gone painful muscle contraction and often painful skin contact.

That is the difficulty with direct faradic and with the galvanic currents.

At the time of the War appeared the Bristow coil, used then and thereafter with real results; and more recently a much improved machine has become available,—the *Morton-Smart* model, not yet widely introduced.

These utilize an interrupted high-frequency faradic current, and in use make possible really painless *non-spastic muscle contractions.* Of their routine use, more later on.

Diathermy, much discussed, is the method by which opposed interrupted high-frequency currents are so applied that *at their meeting point* they develop heat *within the body*, and within a limited area more or less accurately determined.

The fact that the heat so generated is of electrical origin is a matter of concern only in relation to skin contacts. *Diathermy* is not a form of electrical treatment at all, but the application of heat.

As to what is actually done in generation of heat in the body, many extravagant claims have been made in forgetfulness of the fact that the internal cooking of a steak concerns dead tissue, and is in no way comparable to the heating of tissue surrounded and permeated by a rapidly circulating blood stream.

Actually, however, heat is developed and may be made use of, with due caution, to produce vessel dilatation and local hyperaemia. *Diathermy* seems to promote bone repair in this way to some small extent, and has a place in fracture treatment in selected cases.

Now as to what may actually be accomplished in fracture treatment through heat and lights.

Heat is applied in many ways:

- Baking—no light directly applied.
- Heat directly from the ordinary bulb, perhaps the most efficient form.
- Infra-red radiation—the "black light", invisible as light, of relatively high heat value, but with very little penetration, except in short wave infra-red rays.*
- Green and yellow lights, which seem to have no particular rôle, physiologically.
- Violet and ultraviolet rays, with very low penetrating power.†

These last are the rays that exert germicidal and chemical powers, the only differentiated rays that act specifically, and not just as heat.

For our discussion, their value is that they produce changes in blood composition, and in the composition of the skin.

To come back to heat, as such. There is some virtue in the hot sand baking which combines heat and soft pressure on exudates. The same may be said of the hot paraffin bath, also convenient as a supporting medium for active exercises.

Heat and gentle massage are combined in the whirlpool bath, with the air intake of the Hutchins or Titus machines. Useful, decidedly *not* indispensable.

* Most servicable in wave lengths of 7,500 to 14,000 Angstrom units, running up to 50,000, but with danger of too much venous congestive effect in the higher brackets.

† Penetration variously estimated from 0.01 millimeter up, surely not over 0.1 millimeter.

The installation of elaborate plants is probably nowhere needed, certainly not for fracture treatment. A diathermy outfit is needed, perhaps a Smart machine. Nothing else is important except a baker of some sort.

The physiotherapy treatment of fractures should be, very definitely, *not a matter of machines* or apparatus.

What we want to do is to secure repair with the least possible interruption of function.

Complete recovery of function depends on early resumption of function to a great degree.

Restoration of normal circulation means not only active repair, but also the removal of excess exudate, resulting in less excessive deep-scar formation,—less fibrosis of muscle and ligament.

Restoration of muscle activity means preservation of muscle nutrition,—function of joints.

The effective means to the end desired are massage, active motion, and heat.

If we have a *fresh* fracture, the first therapy, if there is effusion into the tissues, is massage *, to cause rapid absorption of blood and lymph under direct manipulation † until nearly normal conditions are restored.

Then comes the reduction and fixation.

Fixation we cannot sacrifice, but apparatus may very often be devised to give opportunity for early massage without sacrificing security, or plaster casings often may safely be cut out to allow this handling, with early motion of joints not intimately involved in the immobilization of the fracture.

Such massage must be gentle, persistent.

To this is added as soon as is safe the beginning of active motion‡. Otto J. Hermann, several years ago, began to cut out plaster over the front of the thigh in cases of hip fracture to allow massage and active motion, with no mishaps and with better results in function.

For several years, on the Bone and Joint Service of the Boston City Hospital, a couple of therapist aides have ranged the wards all day, under close surgical direction, carrying out massage and guarded movements on fractures as early as possible. This treatment has proved abundantly worth while in the average results.

Next, it is possible to get patients into convalescent apparatus much earlier than is usually done, and this means the free use of massage and active motion under control, during *early* convalescence.

And so we come to the later convalescent stage.

This should be the stage of real recovery of function *after weeks of careful physiotherapy.*

* Böhler has well understood the value of this.

† Anyone who has seen the disappearance of knee-joint fluid under the hands of a good masseur knows that more than stimulation of circulation is concerned here.

‡ Sometimes one may well substitute the stimulation of the Smart machine for controlled muscle action, but not as a routine.

Actually, too often, it is the stage when stiff limbs are handed over for the physiotherapist to *begin* on.

And that is the main trouble; for by that time:

The patient has had his fracture;
He has stiff joints not under control;
He has stiff muscles and has no power to use them;
He has a mind already grown clogged, or with the wires down between it and his muscles;
And effort hurts him.

So he is baked and likes it, and loafs and likes it,—and of this no end!

Heat and massage are well enough if we realize—and make the patient realize—that they are of use *only* as preparation for the active exercise and use which is his only salvation.

The real function of a Smart machine is to prove to him that he has real muscles, to make him synchronize his effort with the electric impulse until he learns how to do it himself.*

The physiotherapist is of vast use in two ways:

1. In devising exercises that are easy, utilizing gravity instead of fighting it,—exercises that the patient can learn to do with precision, exercises that risk neither loosening of a recent union, nor overtiring of muscles.

2. In making him do them, at home as well as in the office. In making *him* work, himself.

That is the essential thing,—to make it easy for the patient to bring about his own cure, making him understand that in the end no one else can do more than help *him*.

He must cure himself.

That is the essential doctrine of physiotherapy in fractures.

The prescribing of "baking and massage" in the routine way is not the use of physiotherapy, but a confession of ignorance as to what physiotherapy can do.

* We are quite aware that we are not agreeing with Smart in this estimate of the main value of such therapy.

RECURRENT DISLOCATION OF THE SHOULDER

BY TOUFICK NICOLA, M.D., F.A.C.S., NEW YORK, N. Y.

From the Orthopaedic Department, Mountainside Hospital, Montclair, New Jersey

This paper will be limited to further observations on the operation for recurrent dislocation of the shoulder which the author first described in 1929. Included in this paper is a report of thirty-two cases operated upon by the author.

Each case of recurrent dislocation of the shoulder should be studied to determine the exact pathology that is present. In considering the pathology, it is convenient to divide it into three groups: bony, capsular, and muscular.

In the *bony* group we may have:

1. Defects in the head of the humerus either acquired after the first dislocation, or due to atrophy of the head, infantile paralysis, or congenital defects.

2. Defects in the glenoid cavity, consisting of either acquired fracture of the edge or shallowness of a congenital type.

3. Fractures of the greater or lesser tuberosities of the humerus.

In the *capsular* group we may have:

1. Detachment of the joint capsule from the anterior or inferior margins of the glenoid cavity.

2. Enlargements of the joint from relaxation following repeated tears.

In the *muscular* group we may have:

1. Weakness of the supraspinatus and infraspinatus muscles.

2. Contracted pectoralis major, teres minor, and the latissimus dorsi.

From the pathological consideration, it is seen that in most cases there is usually a combination of two or three of these factors present and to repair only one leaves a loophole for recurrences. To repair all is very difficult and sometimes impossible. The following operation is in principle the same as the original, but has a few improvements and is described in more detail.

DESCRIPTION OF OPERATION

1. The incision begins just outside of the coracoid and passes downward for two and one-half inches in the line of the fibers of the deltoid (Fig. 1).

2. The deltoid fibers are divided by blunt dissection. At this point the circumflex nerve and artery may come into view crossing the wound. If so, care should be taken to avoid injuring them.

3. The tendon of the long head of the biceps is located by feeling for the bicipital groove. The tendon is then exposed up into the shoulder

TABLE I

SUMMARY OF THIRTY-TWO CASES IN WHICH OPERATION WAS PERFORMED FOR RECURRENT DISLOCATION OF THE SHOULDER

Name	Age	Sex	Occupation	No. of Dislocations	Shoulder Affected	Date of Operation	Stay in Hospital	Period Before Return to Occupation	Remarks
Case 1	20	M	Boxer	5 times weekly	Right	Apr. 6, 1928	6 days	5 weeks	
Case 2	27	M	None	2 times weekly	Left	Sept. 8, 1928	10 days	7 weeks	Epileptic, killed in automobile accident, Jan. 17, 1930.
Case 3	20	F	Student	6 times weekly	Right	May 14, 1929	10 days	6 weeks	
Case 4	25	M	Salesman	1 monthly	Right	Nov. 5, 1929	10 days	5 weeks	
Case 5	21	M	None	7 times weekly	Right	Nov. 17, 1929	14 days	2 months	Epileptic.
Case 6	18	F	Student	1 monthly	Right	Dec. 4, 1929	10 days	1 month	
Case 7	30	M	Painter	1 weekly	Right	Mar. 3, 1930	14 days	10 weeks	
Case 8	50	M	Physician	1 monthly	Right	Apr. 4, 1930	3 weeks	3 months	Bronchitis prolonged stay in hospital.
Case 9	24	M	Salesman	1 monthly	Left	Apr. 21, 1930	10 days	2 months	
Case 10	17	F	Student	4 times weekly	Left	June 24, 1930	14 days	2 months	
Case 11	24	M	Clerk	3 times weekly	Right	July 8, 1930	10 days	6 weeks	
Case 12	28	M	Plumber	2 times weekly	Right	July 8, 1930	14 days	10 weeks	
Case 13	35	F	Housewife	1 every 2 weeks	Right	Sept. 4, 1930	14 days	10 weeks	
Case 14	29	M	Laborer	1 every 2 months	Right	Feb. 7, 1931	10 days	3 months	
Case 15	21	M	Student	4 times yearly	Left	Feb. 9, 1931	6 days	3 weeks	
Case 16	40	M	Laborer	5 times monthly	Right	June 6, 1931	14 days	3 months	
Case 17	19	M	Baseball player	1 monthly	Right	June 6, 1931	10 days	6 weeks	
Case 18	20	M	Student	4 times yearly	Right	June 30, 1931	8 days	4 weeks	
Case 19	28	M	Laborer	3 times monthly	Right	Aug. 4, 1931	14 days	3 months	
Case 20	24	M	Student	8 times yearly	Right	Mar. 20, 1932	7 days	6 weeks	
Case 21	29	M	Plumber	4 times monthly	Right	May 4, 1932	18 days	4 months	
Case 22	37	M	Laborer	3 times weekly	Right	Jan. 4, 1933	3 weeks	11 weeks	
Case 23	17	F	Student	9 times yearly	Left	Apr. 9, 1933	10 days	8 weeks	Redislocation in 4 months. No dislocation since.
Case 24	22	M	Student	6 times yearly	Left	Apr. 14, 1933	6 days	3 weeks	
Case 25	20	M	Student	6 times monthly	Right	May 7, 1933	9 days	4 weeks	
Case 26	38	M	Laborer	1 monthly	Right	June 9, 1933	14 days	5 weeks	
Case 27	20	M	Student	4 times monthly	Right	July 11, 1933	10 days	19 days	
Case 28	10	F	Housewife	9 times monthly	Right	July 11, 1933	17 days	5 weeks	
Case 29	26	M	Laborer	4 times weekly	Left	Sept. 7, 1933	14 days	3 months	
Case 30	41	M	Laborer	1 weekly	Right	Sept. 14, 1933	3 weeks	8 weeks	
Case 31	38	M	Lawyer	4 times monthly	Left	Sept. 14, 1933	2 weeks	1 month	
Case 32	24	M	Student	1 monthly	Both	Oct. 3, 1933	10 days	3 weeks	

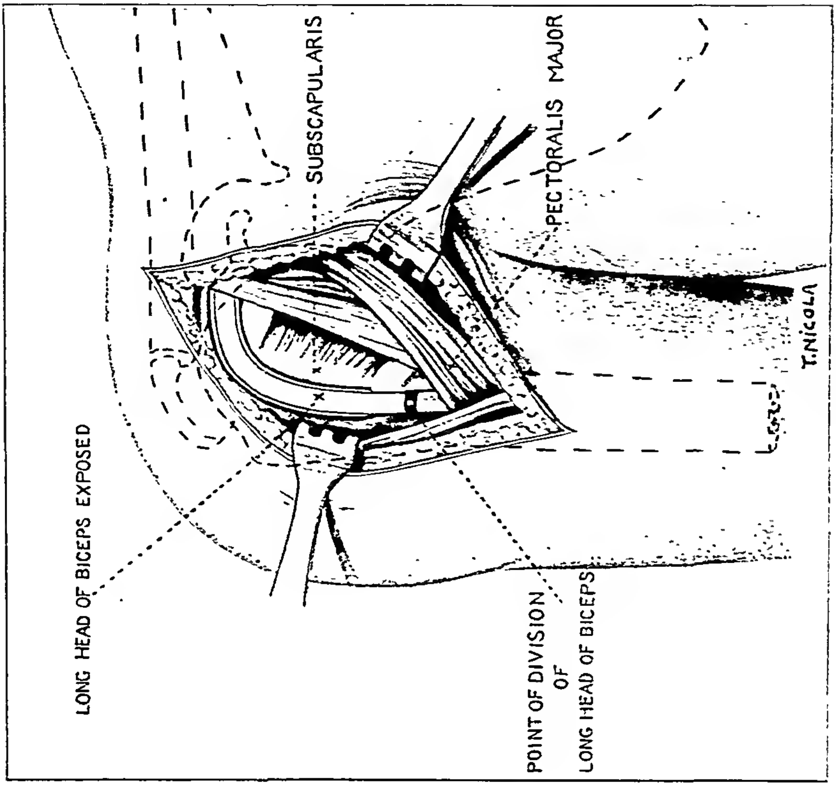

SUBSCAPULARIS
PECTORALIS MAJOR
LONG HEAD OF BICEPS EXPOSED
POINT OF DIVISION OF LONG HEAD OF BICEPS
T. NICOLA

FIG. 2

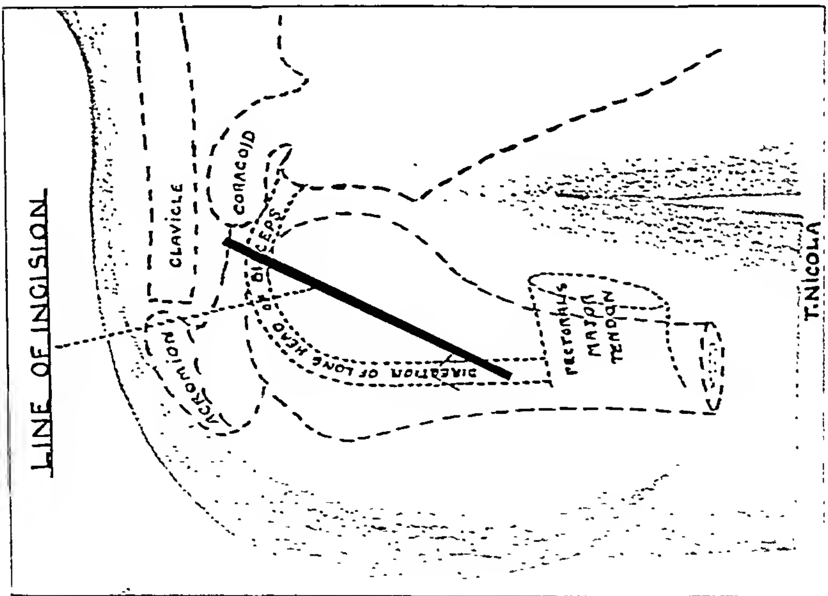

LINE OF INCISION
CLAVICLE
CORACOID
ACROMION
DIRECTION OF LONG HEAD OF BICEPS
PECTORALIS MAJOR TENDON
T. NICOLA

FIG. 1

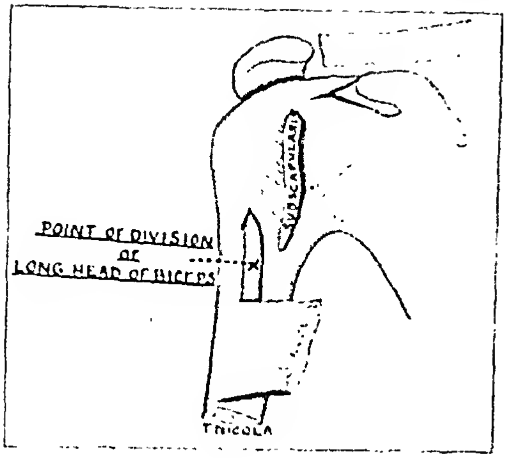


FIG. 3

joint by dividing the transverse humeral ligament, which holds the tendon in the bicipital groove, and by splitting the capsule in the line of the fibers continuous with the transverse humeral ligament. In this step of the operation cutting of the tendon may be avoided by not closing the blades of the scissors while splitting the capsule (Figs. 2, 3, and 4).

4. The tendon of the long head of the biceps is divided about one inch below the cut margin of the transverse humeral ligament, after stay sutures of black silk have been placed in the proximal and distal parts. If this is not done, the distal part will disappear under the tendon of the pectoralis major muscle, thereby prolonging the operation (Fig. 5). The elbow is flexed at about forty-five degrees during this step and throughout the rest of the operation. The synovial covering of the tendon should be removed without fail, so that it becomes fixed in the tunnel in the head of the humerus through which it is later passed.

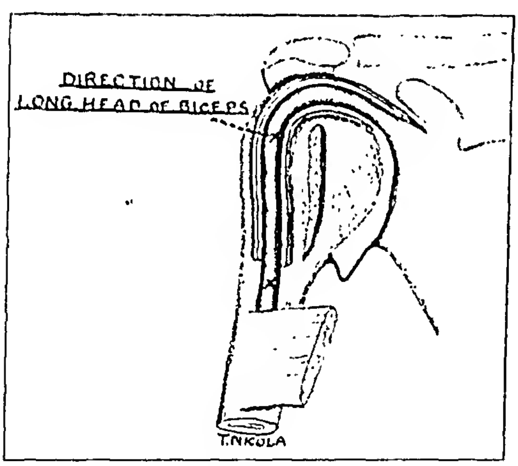


FIG. 4

5. By means of a quarter-inch drill or, better, a quarter-inch gouge (Fig. 5), a hole is then made through the head of the humerus, beginning in the bicipital groove about one inch distal to the lesser tuberosity. This gouge should be so directed that it comes out on the articular head of the humerus in the line of the direction of the tendon, from one-half to three-quarters of an inch from the edge of the articular cartilage. If it comes out less than half an inch from the edge of the articular cartilage, there is a chance for recurrence of the dislocation, because the tendon will not check the arm in extreme abduction. If fixed in the bicipital groove, the tendon will not check the arm until it reaches from 255 to 280 degrees of abduction. This amount of abduction cannot be reached without dislocating the shoulder. The maximum of abduction of a normal shoulder is ninety degrees, and, combined with the scapular movement, the abduction of the shoulder reaches a maximum of 180 degrees.

6. The gouge is then withdrawn and the loose bone marrow is removed from its cavity. The gouge is reinserted and a flexible probe

is passed through the tunnel from the proximal end, guided by the gouge. The probe is then threaded with the black silk which is attached to the proximal part of the divided tendon. The tendon is then drawn through the tunnel and united to the distal part by means of the black silk which was passed through the tendon before it was divided (Figs. 5 and 6).

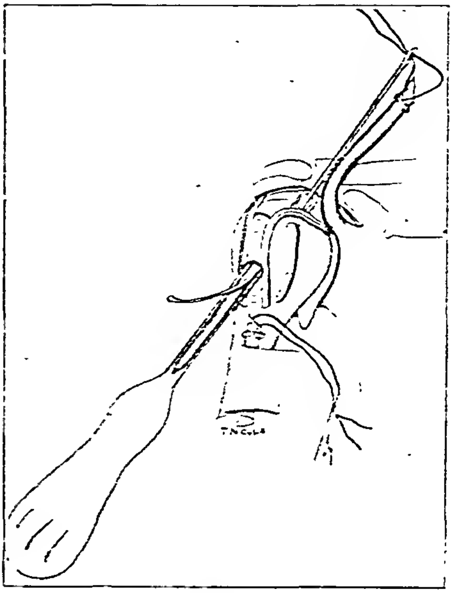


FIG. 5

7. The arm is abducted to a right angle and the transverse humeral ligament is sutured to that part of the tendon of the long head of the biceps which lies in the bicipital groove. This does two things: (1) it insures enough tendon from the head of the humerus to the glenoid cavity, thus removing any restriction of normal abduction; and (2) it holds the tendon from moving up and down in the tunnel, and hastens its fixation in the tunnel.

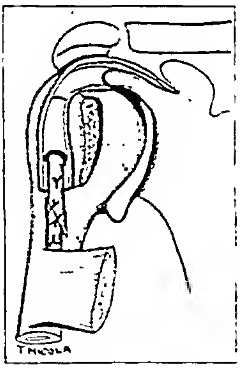


FIG. 6

8. The transverse humeral ligament and the capsule are sewed with continuous No. 1 plain catgut sutures: the split deltoid muscle, with a few interrupted sutures. In women the skin is closed with skin clips or a subcuticular stitch.

9. The shoulder is then put up in a simple Velpeau bandage reinforced with adhesive plaster, with the arm close to the chest and the elbow flexed to forty-five degrees. This position is maintained for two weeks. In epileptics it is wise to keep the shoulder immobilized for at least six weeks. If the operator chooses, the shoulder may be put up in the abducted position of ninety degrees, using a plaster-of-Paris shoulder spica bandage. In twenty-seven consecutive cases operated upon by the author, the simple Velpeau bandage was used with excellent results.

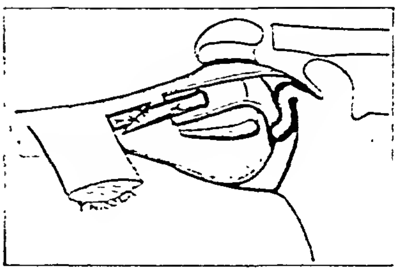


FIG. 7

10. The after-care may include radiant heat, massage, and active movement, with the arm carried in a sling between treatments. In nine of the twenty-seven cases, no physical

therapy treatment was used; these patients made excellent recoveries with no prolongation of the convalescent period, which ranged from four to twelve weeks. Three compensation cases made up the twelve-week convalescent period.

Three cases of recurrence of the dislocation have been reported to the author by various surgeons who have used this operation. In two of these cases, the operator reoperated. In one case, the hole in the head of the humerus was too large, allowing the tendon to move up and down in the tunnel, thereby causing it to fray. In the other case, the hole was not placed far enough on the articular surface of the humerus, so as to check the head when the arm reached 180 degrees of abduction. These recurrences were due, therefore, to faulty technique.

To prove that a normal tendon is strong enough to check the head of the humerus from redislocating, experiments on the tensile strength of the live tendon of the long head of the biceps were carried out. Four tendons were tested. The first two were removed from patients upon whom arthrodesis of the shoulder was performed—one, a boy of seventeen; the other, a boy of twelve. The other two tendons were removed four hours after death from two men who had been killed in automobile accidents.

Specimen 1*. Boy, aged seventeen years. Four inches of tendon of the long head of the biceps was removed for examination. The specimen was kept in normal saline for two hours before examination.

Dimensions of section— .125 by .199
Area in square inches— .02485
Maximum load in pounds (actual)—210
Tensile strength— 6,910 pounds per square inch
Load in pounds— 0–10 –20 –30 –40 –50 –60 –70 –80
Percentage of elongation—0–1.08–2.16–3.22–4.3–4.3–4.3–5.37–5.37

Specimen 2*. Boy, aged twelve years. Four and one-half inches of tendon of the long head of the biceps was removed for examination. The specimen was kept in normal saline for five hours before examination.

Dimensions of section— .131 by .124
Area in square inches— .01624
Maximum load in pounds (actual)— 179
Tensile strength— 7,810 pounds per square inch
Load in pounds— 0–10 –20 –30 –40 –50 –60 –70 –80 –90
Percentage of elongation—0–1.03–1.8–2.1–2.1–3.1–3.9–4.4–5.1–5.1

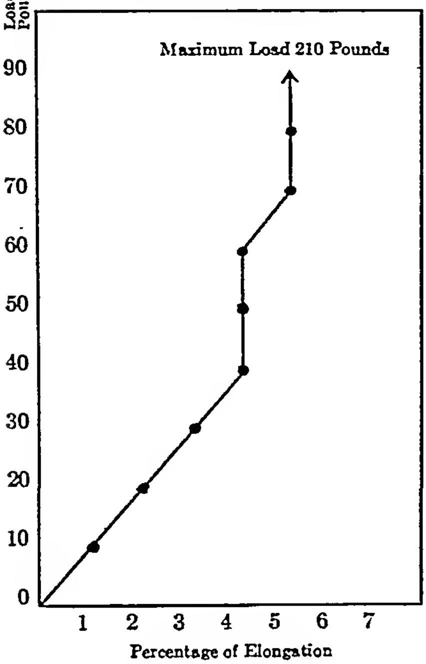
Specimen 3*. Man, aged twenty-nine years. Four inches of tendon of the long head of the biceps was removed for examination. The specimen was removed four hours after death and examined three hours later.

Dimensions of section— .2 by .194
Area in square inches— .0388
Maximum load in pounds (actual)—278
Tensile strength— 7,360 pounds per square inch
Load in pounds— 0–10 –20 –30 –40 –50 –60 –70 –80 –90
Percentage of elongation—0–1.07–1.9–3.06–3.2–4.4–5.1–5.4–5.4–5.4

* Tests made by New York Testing Laboratories, G. Horowitz, Engineer.

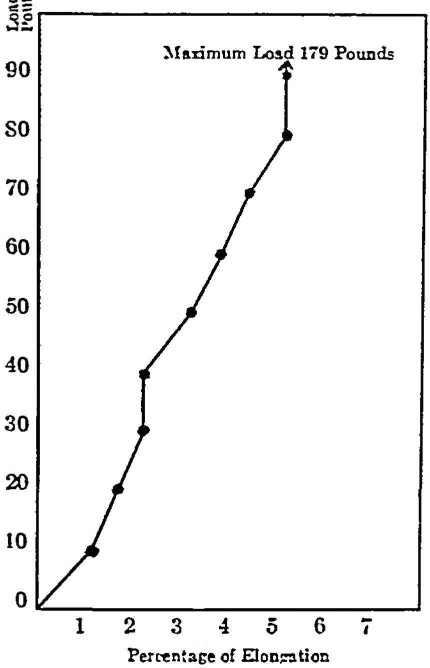
SPECIMEN 1

Tensile Strength — 6,910 Pounds per Square Inch



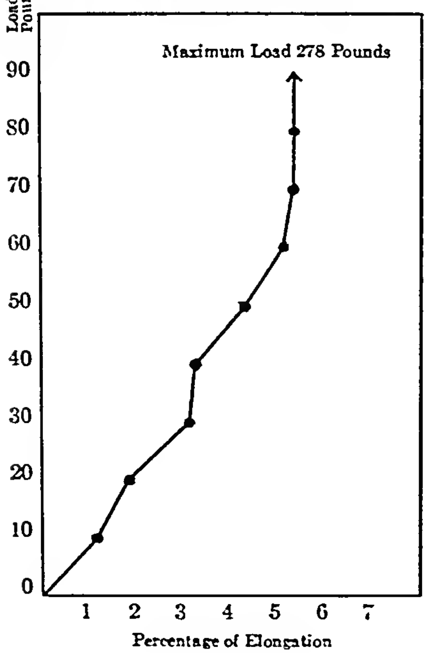
SPECIMEN 2

Tensile Strength — 7,810 Pounds per Square Inch



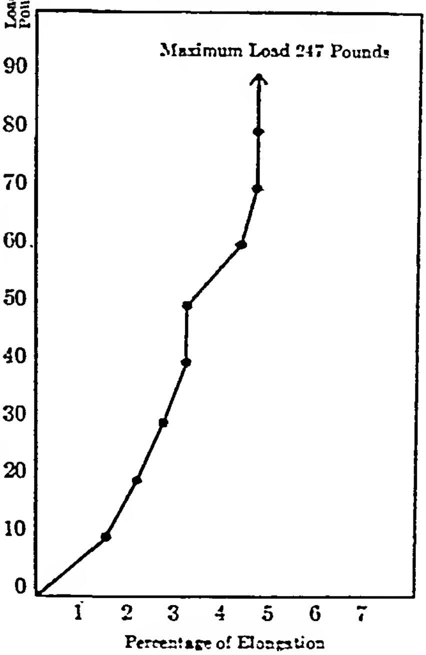
SPECIMEN 3

Tensile Strength — 7,360 Pounds per Square Inch



SPECIMEN 4

Tensile Strength — 7,240 Pounds per Square Inch



Specimen 4*. Man, aged forty-five years. Four inches of tendon of the long head of the biceps was removed for examination four hours after death due to trauma. The specimen was kept in normal saline for two hours before examination.

Dimensions of section—	.214 by .191
Area in square inches—	.01087
Maximum load in pounds (actual)—	247
Tensile strength—	7,240 pounds per square inch
Load in pounds—	0-10 -20 -30 -40 -50 -60 -70 -80 -90
Percentage of elongation—	0-1.6-2.13-2.8-3.1-3.1-4.2-4.7-4.7-4.7

SUMMARY

1. The operation is simple.
2. It can be used in all cases, whether the pathology be bony, capsular, or muscular.
3. There is practically no restriction of motion of the shoulder.
4. Convalescence is short.
5. Tensile strength of tendon of the long head of the biceps varies from 6,910 to 7,810 pounds per square inch.
6. The maximum load in pounds (actual) for the tendon of the long head of the biceps varies from 179 to 276 pounds.

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*Tests made by New York Testing Laboratories, G. Horowitz, Engineer.

KNEE-JOINT VISUALIZATION

A Roentgenographic Study with Iopax

BY DOUGLAS BOYD, M.D., HIGHLAND PARK, ILLINOIS

From the Arthritis Clinic, Department of Medicine, Northwestern University Medical School Chicago, Illinois

A clinical roentgenographic study was begun early in 1932 in the Arthritis Clinic of the Northwestern University Medical School, using iopax solution in the knee joint in an attempt to learn its value and limitations for visualization of the synovial pouches of this joint. While relatively few joints have been studied, we have seen no unfavorable reactions; the roentgenograms have suggested clearer diagnoses; and we have noted some unexpected therapeutic benefit in several instances.

Iopax seemed to offer an easily handled solution which overcame some of the definite objections to fluids previously used [1]. Iopax, readily soluble in water, rapidly mixed with the watery fluids present in the joints. Its pressure was more easily controlled at all stages; and its removal was more completely accomplished than that of the oily fluids. It was well known that this material was rapidly excreted by the kidneys and that it gave good contrast shadows. The ease and safety with which arteries had been visualized by Dr. Geza de Takats [2] suggested the use of this substance in the knee joint.

Iopax was used in a similar study in the Clinic of Michaëlis in Germany, reported in 1931 [3]. His study was a diagnostic one, made of patients with a persistent effusion. There were no serious reactions, except that some bleeding occurred in those joints which had suffered recent trauma. Michaëlis noted that the solution was rapidly absorbed: the shadow greatly diminished in one hour, and in three to five hours no shadow remained in or about the joint. He did not aspirate the drug because of this rapid absorption. His technique was much the same as that used in our Clinic, with this important difference,—that his patients were kept in bed under observation for one or two days. Table I shows some details of his group of cases.

METHOD

All patients studied in our Clinic were ambulatory,—clinic or private patients. They were taken directly to the x-ray table without previous preparation. Here the injections were made with surgical aseptic technique. The solution used was an autoclaved thirty per cent. iopax, dissolved in five-tenths per cent. novocain. Injection was made directly into the suprapatellar pouch, from the lateral aspect of the joint at the level of the superior border of the patella.

TABLE I

From Study of Michaëlis (*Röntgenpraxis* III, 320, 1931).

Case No.	Age Sex	Diagnosis and Etiology	Puncture Fluid	Iopax Injection	Reaction
1	38 Male	Arthritis, 3 years. Unknown etiology. Culture pneumococcus.	120 c. c., turbid, serous.	40 c. c.	None.
2	13 Male	Hemarthrosis, recent trauma.	80 c. c., blood.	40 c. c.	Immediate pain, hemorrhage.
3	48 Male	Chronic arthritis. Cultures sterile.	50 c. c., turbid, serous.	40 c. c.	Temperature of 102 for 24 hours.
4	10 Male	Congenital lues. Wassermann +++, Tuberculin 0.	60 c. c., serous.	40 c. c.	None.
5	60 Male	Tuberculosis of knee joint. Culture positive for tubercle bacillus.	100 c. c., turbid, serous.	40 c. c.	None.
6	26 Male	Trauma, 3 weeks. Culture sterile.	80 c. c., turbid, serous.	50 c. c.	Ambulatory. None.
7	38 Male	Effusion of knee. Etiology unknown. Cultures sterile.	50 c. c., clear.	40 c. c.	None.
8	60 Female	Tabetic arthropathy.	150 c. c., clear.	80 c. c.	None.
9	19 Female	Effusion of knee. Etiology unknown.	60 c. c., clear.	40 c. c.	None. Ambulatory.
10	45 Male	Fracture of patella, 3 weeks.	40 c. c., bloody fluid.	30 c. c.	Burning pain, 15 minutes.
11	54 Female	? Ganglion. Cultures sterile.	50 c. c., clear.	40 c. c.	None.
12	20 Male	Trauma, 2 years before. Cultures sterile.	80 c. c., serous.	60 c. c.	Burning for half hour; discomfort for 48 hours.

The joints with effusion were first aspirated; as much of the fluid as possible was removed, and this was replaced with the iopax solution. Roentgenograms were taken in both planes. Then the leg was manipulated through as full a range as possible, and second films were made with the leg in flexion. Only in this way could distribution of the fluid to the posterior pouch be obtained.

In joints without effusion salt solution was first injected; this was withdrawn to make certain of the needle position, and then the iopax solution was injected. Complete distribution necessitated some distention of the synovial sac, which caused discomfort. In some of the

TABLE II

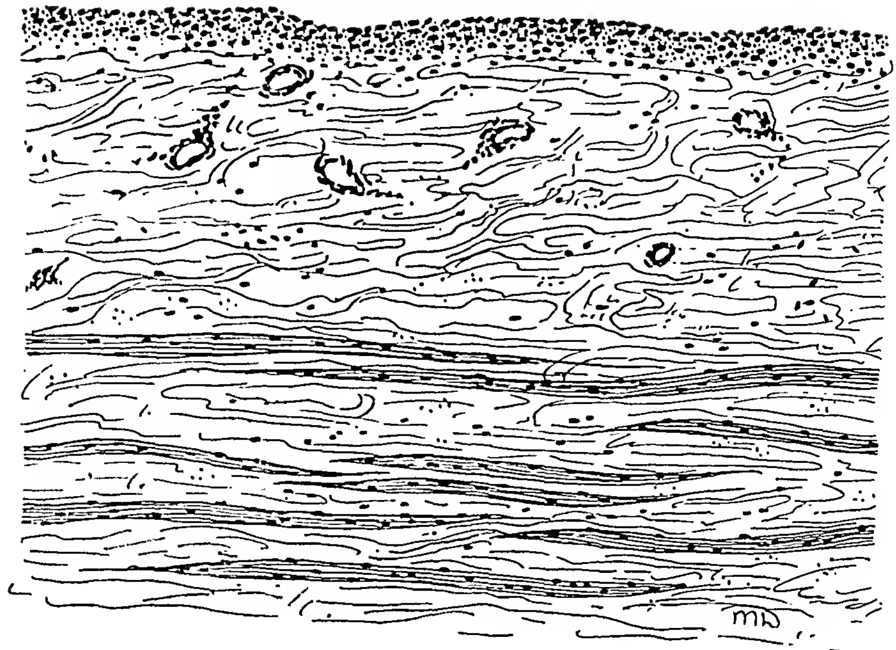
CASES STUDIED AT ARTHRITIS CLINIC, NORTHWESTERN UNIVERSITY MEDICAL SCHOOL

Case No.	Age Sex	Diagnosis and Etiology	Fluid Removed	Iopax Injection	Reaction	Remarks
1	29 Female	Villous synovitis. Etiology unknown.	None.	20 c. c.	Local pain, 48 hours. No fever.	Pain rapidly subsided. No permanent effects.
2	61 Female	Hypertrophic arthritis. Etiology ?	None.	35 c. c.	Severe pain, 48 hours.	Freedom from pain for 2 months after injection, the longest period she had been comfortable.
3	50 Male	Charcot joint. Syphilis.	None.	40 c. c.	None.	No effects noted.
4	28 Male	Infectious arthritis. Culture, no growth.	40 c. c., turbid, yellow.	35 c. c.	Immediate burning pain, lasted 48 hours.	Effusion did not return. Freedom from pain for 5½ months.
5	32 Male	Synovitis. Popliteal bursitis. Culture, no growth.	6 c. c., lime colored, turbid fluid.	28 c. c.	None.	No change. Fluid in knee joint and ganglion returned.
6	33 Male	Infectious arthritis. Culture, no growth.	25 c. c., turbid, yellow.	22 c. c.	Slight discomfort, 24 hours.	Relief from pain for 2 weeks. Pain and fluid reappeared, then gradually disappeared. No symptoms for past 10 months.
7	36 Female	Infectious arthritis. Culture sterile.	34 c. c., turbid, yellow.	22 c. c.	Very little discomfort.	Some relief of pain for 4 weeks.

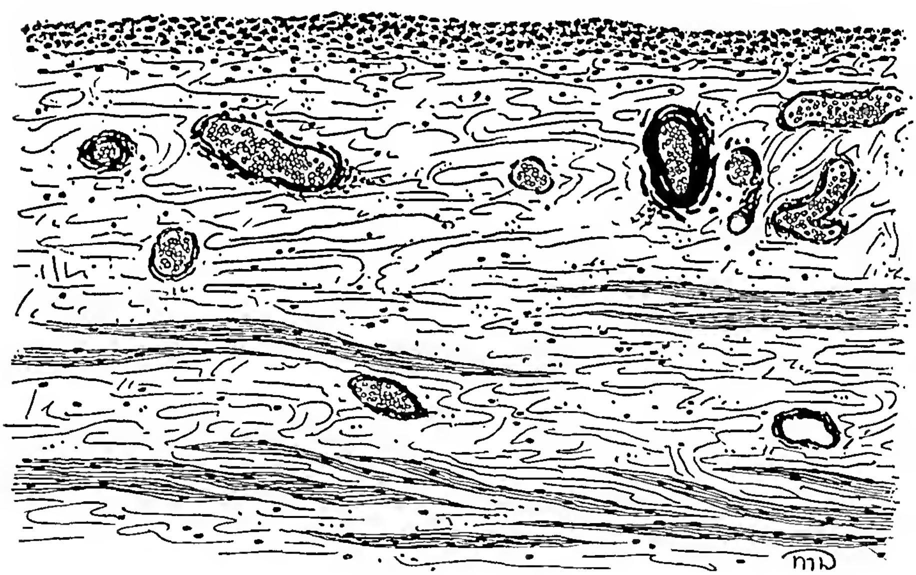
patients, after the roentgenograms had been taken, as much of the solution as possible was withdrawn, but there was no noticeable effect on the discomfort.

A sterile dressing was placed over the puncture site with a snug elastic bandage over the joint. Patients were advised to remain quiet in bed at home for a period of forty-eight hours, and to apply heat to the area of the joint.

In these patients from twenty to forty cubic centimeters of the solution was used, depending on the amount of distention and pain produced. In the later injections relatively less solution was used, and yet the shadows in the roentgenograms seemed to be equally clear. For the average



A



B

FIG. 1

Photomicrographs of sections from dogs' joints, showing: in *A* the appearance of the synovia and subsynovial tissues from an uninjected joint, and in *B* similar tissue from an injected joint. *B* shows the engorgement of the subsynovial blood vessels five days after injection, but no cellular exudate.

knee approximately twenty-five to thirty-five cubic centimeters is sufficient and is well within the safe limit. More than two ounces (60 cubic centimeters) should not be used, for the distention grows relatively more dangerous as 100 cubic centimeters is approached. As was pointed out

by Colp and Klingenstein [4], rupture of the suprapatellar or postcondylar pouches will usually occur on injection of 100 cubic centimeters of fluid.

EXPERIMENTAL STUDY

To make sure that the solution would not produce too much chemical irritation, a study was first made of synovial tissue obtained from the knee joints of two dogs injected with iopax solution. The uninjected joints were used for controls.

The technique here described was followed. The dogs were anaesthetized with ether; the area about the knee was shaved and prepared with iodine-alcohol. The joint cavity was easily entered by directing a medium-sized, short-bevel needle beneath the patella. Synovial fluid was seen to drop from the needle before injection was done. Iopax solution was then injected to produce a moderate symmetrical distention of the joint capsule. The dogs were then allowed to recover. No dressings were used and there appeared to be no leakage from the puncture wounds.

Examination of the joint tissues from Dog A, sacrificed on the fifth day, showed the cartilage of both joints to be smooth, creamy white, and glistening. A few drops of clear synovial fluid were noted in each. No gross difference was seen between the control and the injected joints.

Dog B had no local swelling at any time; he was sacrificed on the sixth day. Gross examination of the injected knee joint showed injection of the small blood vessels on the anterior aspect of the synovial lining beneath the patella. Only two or three drops of clear synovial fluid were seen. The synovia was smooth, glistening, creamy white in color, except as noted. Several blocks were cut from both the control and the injected joints for microscopic study. The controls showed uniformly a normal layer of mesothelium, overlaying a membrane propria rather rich in blood vessels. Beneath this, in various areas, was found either fat, or striated muscle, or heavy fibrous tissue. The injected joints showed pictures similar to the controls, the only change being a moderate tendency to dilatation of blood vessels, but without cellular exudation. Figure I shows drawings of the microscopic findings.

CASE STUDIES

The first injection was done on a woman (L. C.), of twenty-nine years, who complained of crackling in the knee joints of one year's duration. No other joints were involved. There was no history of trauma, no effusion, no locking of the joint, and no loss of function. Examination revealed some generalized thickening about both knees, with a loud crepitus on motion. This was made louder on weight-bearing motion. Roentgenograms of the knees were reported to show no disease. We tried to inject twenty cubic centimeters of a thirty per cent. iopax solution into her right knee. Roentgenograms showed that the solution was outside the knee cavity, extending upward in the fascial planes of the upper leg, just lateral to the suprapatellar pouch. There was local pain in this area for about forty-eight hours, when the pain subsided, and it has not returned. No reaction occurred in the periarticular tissues.

Fig. 2

Case 5. Roentgenogram of injected popliteal bursa, taken immediately after injection.

This faulty injection proved that the solution would do no actual harm, even when injected into the tissue spaces.

The second patient, a woman of sixty-one years, had a hypertrophic arthritis of both knees, with considerable pain and recurring effusion in the left knee, which was moderately swollen. Plain roentgenograms showed some spur formation, but no change in the articular surfaces. No fluid was removed from this knee; thirty-five cubic centimeters of a thirty per cent. iopax solution was injected into the suprapatellar pouch. Roentgenograms made immediately showed definite irregularity of the synovial outline with a diagonal division of negative shadow running across the suprapatellar pouch. The woman complained of rather more severe pain in this knee for forty-eight hours, and then, strangely enough, was completely free from any pain in this knee for sixty days. This was the longest period of freedom from pain she could recall in recent years. The other knee continued to pain her during this time.

The third patient, a man of fifty years, with known lues, was chosen because he had a Charcot knee joint. An attempt was made to gain a clearer picture of the changes in the knee capsule in its obvious pathological state. We did not gain a good outline of this joint space, but we were able to localize several rounded, calcified, loose bodies definitely within the joint. These appeared as areas of increased density, with a halo shadow of decreased density about them. This patient, as was expected, suffered no discomfort, either at the time of the injection or later.

In an earlier Charcot joint, a much clearer definition should be obtained, and would, perhaps, be of differential diagnostic value.

The fourth patient, a young man of twenty-eight years, complained of a swollen, painful right knee. This swelling and pain had appeared one week before, without antecedent trauma. The right knee was stiff and particularly painful on weight-bearing, so that the patient had to use a cane in walking. With this there was a limp and failure to flex the knee more than a few degrees. Examination revealed an effusion, and pain on pressure or motion over the area of the semilunar cartilage and attachment of the internal lateral ligaments.

Roentgenograms showed no evidence of disease in the bones or joint. The joint space appeared normal. A diagnosis of acute synovitis of unknown etiology was made and the man was treated by the usual means of strapping, rest, and salicylates for one month. Neither the pain nor the effusion disappeared.

Five weeks after he came under observation, injection was done. First forty cubic centimeters of a turbid, yellow fluid was withdrawn from the joint. Iopax solution was immediately injected to distend the bursa. When thirty-five cubic centimeters had been injected, the patient complained of considerable pain. About five cubic centimeters was withdrawn, with relief, and a roentgenogram was made. The report of Dr. James T. Case on these films stated: "Opaque media has been injected into the bursa of the right knee. We noted an irregularity of the bursa having a jagged appearance. This is seen to the best advantage when just anterior to the knee joint proper. These findings are, I believe, compatible with a hypertrophy or thickening of the bursal lining."

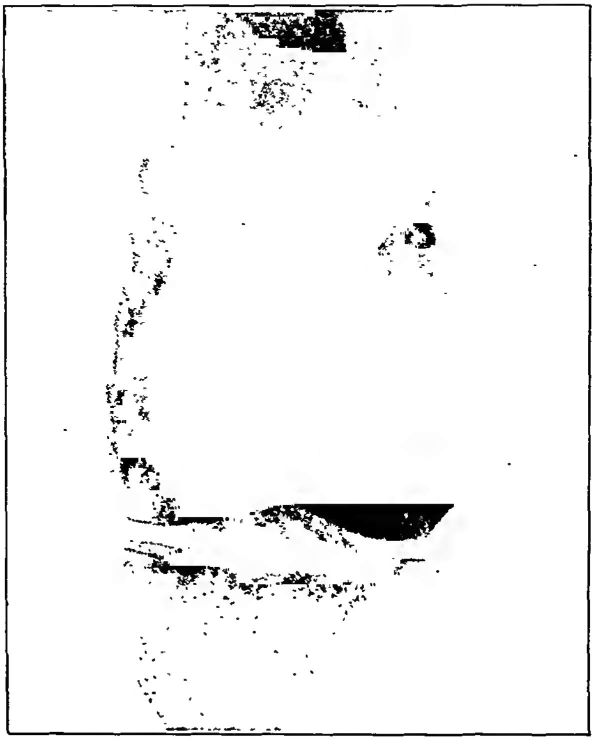


FIG. 3

Case 6. Roentgenogram demonstrating a very irregular suprapatellar pouch. Twenty-two cubic centimeters of iopax solution had been injected.

The injected fluid gave this patient some burning pain in the knee, which disappeared gradually in forty-eight hours. One week later there had been no return of the effusion; the pain was much less severe, and was noted slightly when the knee was twisted. This improvement continued until the patient reported, eight weeks later, that the knee did not pain him; the effusion had not returned. The knee showed a full range of motion at this time. The man was last seen fifteen weeks after injection, was free of pain, walked with a normal gait, and showed no effusion. He felt he no longer needed treatment and would not return to the Clinic again.

The fifth patient, a man of thirty-two years, came complaining of swollen stiff knees of eight years' duration. We found smooth, rounded, tense, fluctuant masses occupying a large part of each popliteal space. These tumors did not pulsate. They were made more prominent and more tense on full extension of the leg; complete flexion was blocked by these masses. They were ganglia.

Plain roentgenograms showed some small spur formation on the posterior edge of the right tibia, but no other evidence of change in the joints.

Two iopax injections were done on one knee in this patient. The first was made into the suprapatellar pouch after removal of some six cubic centimeters of an olive-colored,

Fig. 4

Case 7. Roentgenogram of an irregular, narrowed synovial pouch, taken immediately after twenty-two cubic centimeters of iopax solution had been injected.

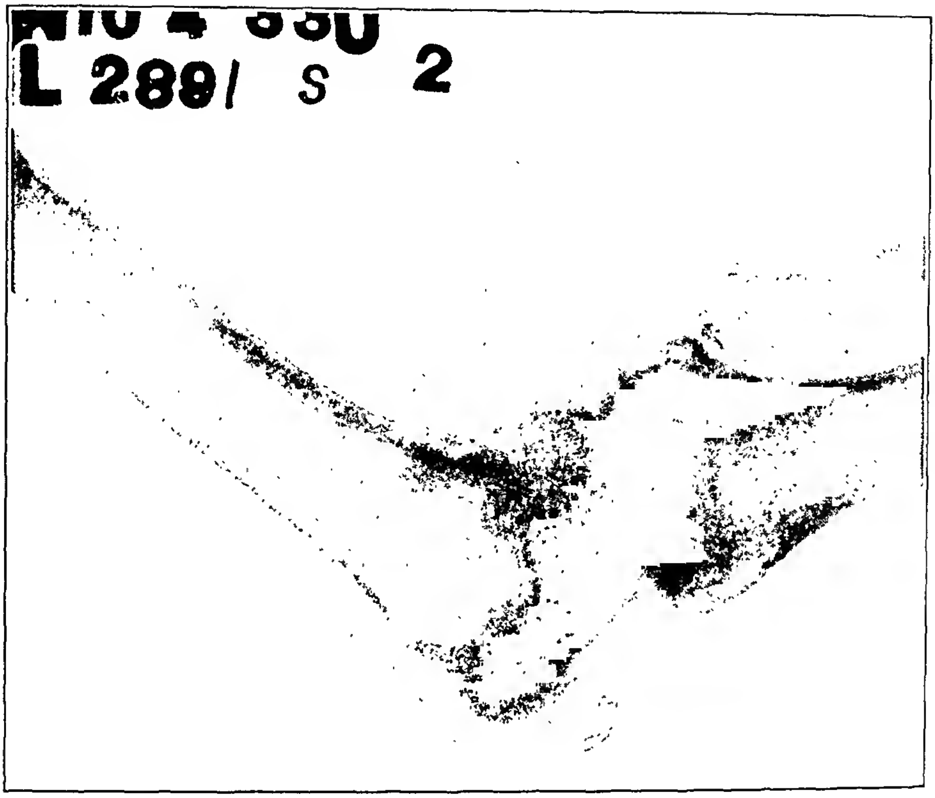


Fig. 5

Case 7. Roentgenogram taken two hours after injection. Incomplete absorption has taken place.

viscid, turbid fluid. Approximately twenty-eight cubic centimeters of the iopax solution was then injected. This gave a good visualization of the anterior chambers of the knee, but did not demonstrate any communication with the bursae in the popliteal space. There was no discomfort following this procedure. A week later an injection was made posteriorly directly into the bursa of the same joint. This demonstrated clearly the outline and extent of the bursa, but did not show any communication with the knee joint, as shown in Figure 2.

We felt that this visualization clearly set this bursa apart from the joint proper, and so made surgery appear less hazardous.

The sixth patient was a man, thirty-three years old, who had an infectious arthritis of fifteen months' duration. In the sixth month of his illness he began to have considerable pain in his knee. This joint became swollen, hot, and painful on motion,—particularly motion undertaken after a period of rest. The effusion and stiffness remained and increased; the local heat decreased; weight-bearing and motion remained painful. The soft tissues about this knee became thickened, until the borders of the suprapatellar pouch could be easily outlined by palpation. Medical treatment did not give relief; instead this knee seemed to grow more painful and have less motion as time elapsed. Eight months after the onset of the local involvement, puncture of this knee joint was done and iopax injected. Some twenty-five cubic centimeters of a turbid, yellow fluid was removed, and this was followed immediately by injection of twenty-two cubic centimeters of the iopax solution. There was no immediate pain. Roentgenograms showed a surprisingly irregular synovial pouch, with a scalloped edge, corresponding to the thickening observed by palpation (Fig. 3). This apparently confirmed the diagnosis of hypertrophic synovitis; and the operative removal of this synovia was advised, but operation was refused. Ten weeks after the injection, the patient reported that he was feeling so much better that he had returned to work,—this was after an absence of some fifteen months. He had stopped all treatment. The knee was no longer swollen, the synovial edge could not be palpated. There was a full range of motion; but some protection, on rising from a low chair and in using the stairs, was still evident. He was able to do a full day's work in his garden or in his office in Chicago.

The seventh injection was done into the knee of a woman thirty-six years old. The diagnosis was infectious arthritis, of nine years' duration. The knee was thickened and swollen, with both soft-tissue induration and effusion. Motion was present,—extension, 150 degrees, to flexion, 60 degrees. The roentgenograms (Figs. 4 and 5) show an irregular synovial pouch, with some narrowing in the suprapatellar area, and a large irregular posterior condylar pouch. The second of these films (Fig. 5) was taken two hours after the injection and shows considerable absorption of the opaque solution.

The rapidity of this absorption from a joint so obviously diseased, confirms the statement of Michaëlis that iopax solution is absorbed from the joint in a few hours.

Table II gives a summary of these cases from our Clinic.

COMMENT

It appears significant that seven patients in this group had knee-joint injections without an unfavorable reaction. Even in the first patient, where the injected fluid was placed outside the synovial sac, no more serious discomfort was suffered than by those in whom the injections were more successful. The most serious reaction noted was increased pain for forty-eight hours. No patient had symptoms of fever; none

noted any local redness at the puncture site or joint area. In none of these patients did the pain last longer than seventy-two hours. Surprisingly enough, three of the seven patients had relief from the previous joint pain and effusion for from two months to six months. This was not anticipated, and would not in our opinion justify joint injection unless other more conservative measures had failed.

It is difficult to evaluate the diagnostic value of the reports cited, in view of the difficulties of getting surgical exposures of the joint lining and in obtaining tissues for pathological study.

One should have a larger acquaintance with the x-ray appearance of knees so injected before giving a dogmatic interpretation of the roentgenograms. We believe the method has diagnostic value, particularly in separating the chronic arthritic knee from those joints which might more readily yield to surgical treatment,—namely, the doubtful displaced cartilages, loose bodies, the true hypertrophic synovitis, and erosions of the weight-bearing surfaces of the cartilage. We believe it may also be of value in the diagnosis of early syphilitic and tuberculous joints, as well as in a more complete study of certain old traumatic conditions of the knee. With experience in studying further roentgenograms of such injected joints, we believe we will be able to read more clearly the positive and the negative shadows that give a composite picture of the outline of the synovial sac and the contours of the joint cartilages. We are continuing this study.

SUMMARY

Thirty per cent. iopax, dissolved in a five-tenths per cent. procaine solution was used to visualize knee joints in a small number of cases. This solution did not cause serious reactions and was quickly absorbed from the joints. The method seems safe and, while it has been used only for diagnostic purposes, it may even yield therapeutic results. The solution used produced a hyperaemia of the synovial membrane, but no cellular exudate.

The author wishes to acknowledge with gratitude the valuable suggestions and help of Dr. Geza de Takats and Dr. D. E. Markson. Shering and Gatz were generous in supplying the iopax for this study.

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OSTEOID-TISSUE-FORMING TUMOR SIMULATING ANNULAR SEQUESTRUM *†

BY HENRY MILCH, M.D., F.A.C.S., NEW YORK, N. Y.

In a report appearing in 1930, Hitzrot [1] described an unusual case which he considered "a sclerosing osteomyelitis of the carpal scaphoid", though he was not certain that it should not be considered "a sclerosing type of bone tumor". The patient was a woman who had injured her wrist while changing her automobile tire. The wrist was swollen and painful and on roentgenographic examination showed in the distal half of the left carpal scaphoid, "a ring-like shadow of sclerosed bone with a darker decalcified-appearing central portion. In this darker area is a rounded, very dense piece of bone, about the size and shape of a green pea." At operation the bone was white, sclerotic, and separated from the rest of the bone as by a capsule. The histological section showed "very dense, atypical bone. The lamellae are irregular. Lacunae are present, but small and no marrow cavity is found."

This unusual picture naturally impressed itself on our mind, particularly as to the significance of the roentgenographic appearance of the lesion. This became of special moment, because, in the first case which we had the opportunity of observing, the question of the liability of an insurance company for an alleged injury was raised. As a result of the patient's refusal to submit to operation at that time, the answer to the question had to be deferred; within a relatively short time, three other almost identical cases have presented themselves. Except for the variety of their location, these cases are similar in history, clinical findings, roentgenographic examination, and histological study; and resemble Hitzrot's case in such detail that we believe all should be grouped in the same category.

CASE REPORTS

CASE 1. S. T., male, aged twenty-two years, single, stated that on May 1, 1933, he had struck the outer side of his right radius against a buffing machine. He complained of slight pain, but was able to continue at his work until the last day of the same month, when he noted swelling and redness of the wrist, with so much pain that he was unable to continue with his work. He was treated by another physician, who applied antero-posterior splints, with some relief of pain. When seen on June 26, 1933, there was present a non-fluctuating swelling above the right wrist. There was marked tenderness on pressure over the palmar aspect of the right radial styloid, with slight redness in this area. Motion of the wrist was limited in all directions, but especially in flexion and extension. There appeared to be no involvement of the hand or fingers. The x-ray showed a dark, annular shadow, surrounded by an area of osteoporosis in the lower, outer portion of the right radial styloid, and apparently involving the wrist joint. At that time a diagnosis of bone abscess, with annular sequestration, was made: operation was advised, but this

* From the Orthopaedic Service of Dr. Harry Finkelstein, Hospital for Joint Diseases, New York.

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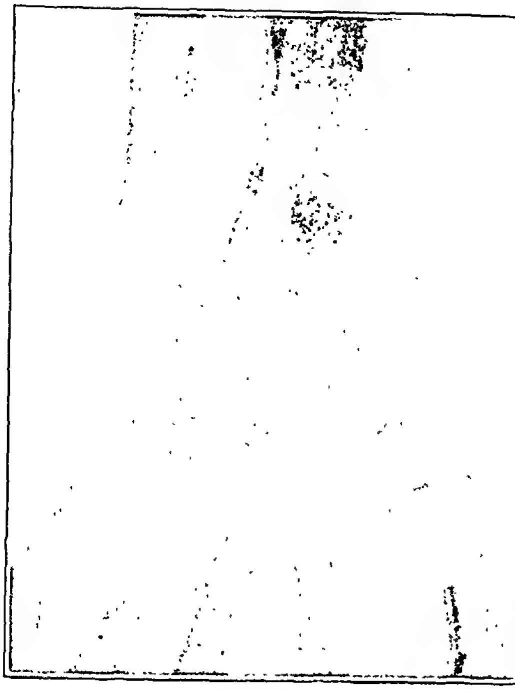

FIG. 1-A

Case 1. Note annular shadow, with reaction about the site of the lesion in the right radius. Roentgenogram taken five months after alleged injury.

FIG. 1-B

Postoperative roentgenogram. Remnants of calcific deposits in soft tissues around site of original lesion.

the patient refused. Subsequently the area of involvement seemed to grow larger and the roentgenogram (Fig. 1-A) showed what appeared to be a definite calcification in the region of the flexor tendons. The pain became worse and finally, in December 1933, the patient was operated on by Dr. Harold M. Rabinowitz, to whom I am indebted for the further details of this case. At operation the lower end of the radius was found markedly thickened by extremely sclerotic bone. The tendons on the anterior aspect of the wrist were involved in this process of ossification. When these were freed and the radius exposed "an encapsulated button of bone was found in the lower end of the radius, involving the articular surface". There was no pus and no evidence of osteomyelitis. (The pathological section examined at another hospital was reported as showing "chronic inflammation".) The patient's wound apparently healed kindly, though at the present time he still has some pain and limitation of motion in the wrist.

CASE 2. A. McC., male, aged twenty-three years, was admitted to the Hospital on June 26, 1933, with a diagnosis of tuberculosis of the left astragalus. The patient observed that he had slipped and hurt his left ankle about four years before. A hematoma, which had developed just anterior to the internal malleolus, had cleared up within several days and the patient had had no symptoms until two years later, when he again began to complain of stiffness, tenderness, and a sense of fatigue in the left ankle. This fatigue he described as "a feeling that the sinews were being cut in the leg". This apparently became worse on exertion and he had a constant limp, though it did not increase markedly. Three months previous to admission he had been seen by an osteopath, who had stretched the ankle several times, and since that time the pain had become more marked, the ankle had become swollen, and the stiffness and limp had increased.

Examination disclosed a swelling of the anteromedial aspect of the left ankle joint, just in front of the internal malleolus. This mass was about an inch and a half in diameter, tense, and slightly fluctuating. There was no redness or local heat, but there was marked tenderness on pressure. All motions of the ankle were painless and similar to those of the right leg, except for slight limitation of dorsal extension. The quantitative

tuberculin test was negative; the blood count was normal; the Wassermann was negative. The roentgenogram (Fig. 2) showed a cup-shaped area of osteoporosis at the superior surface of the junction of the head and neck of the astragalus. In the center of this area there was a sclerotic, rounded area of bone, suggesting a sequestrum.

On June 29, 1933, operation was performed through a three-inch anterior incision, extending distally from the ankle joint. On retracting the wound, the tissues over the astragalus were found very oedematous and the bone irregular. The cartilage overlying the diseased area was loose. The localized area of diseased bone was about one and one-half centimeters in diameter and extended into the neck of the astragalus. The attempt to remove this by means of a curet was unavailing, so that the whole mass had to be gouged out with an osteotome. Cultures were taken, the cavity was packed, and a plaster-of-Paris cast applied. Smears and guinea-pig inoculation from the tissue removed at operation were reported negative for tuberculosis.

The pathological report by Dr. Jaffe showed "a tumor process characterized by the formation of large amounts of osteoid and fibrous bone. The circular fragment shows considerable induration of the tumor bone peripherally. *Diagnosis:* Osteoid-tissue-forming tumor of the astragalus (benign)." Since operation the wound has healed completely and x-ray shows no evidence of recurrence at the present time. The patient, however, still complains of slight pain, especially on weight-bearing. This may, of course, be due to the operative trauma rather than to the presence of bone tumor.

Case 3. S. L., male, aged fifteen, was admitted to the Hospital on May 8, 1933, with a complaint of pain in the lower external aspect of the left leg of two months' duration. There was no previous history of acute infection or recent trauma. The pain, of a dull, boring character, began gradually and had increased so that it interfered with sleep.

Examination disclosed a swelling of the lower left leg, extending from the tip of the external malleolus upward for a distance of about three inches. There was no fluctuation or redness, but there was slight increase in the surface temperature. The ankle joint showed no limitation of motion whatsoever. The Wassermann test was negative, the tuberculin test moderately positive in high dilution. The roentgenogram (Fig. 3), re-

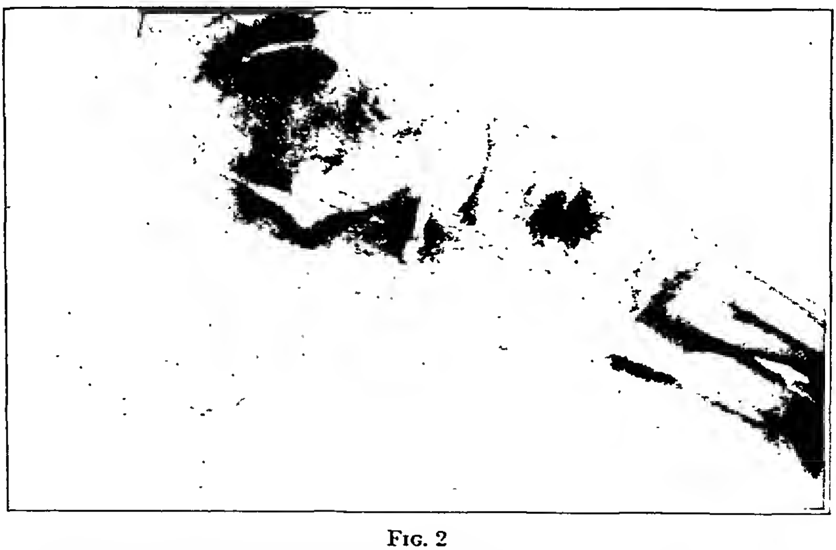

Fig. 2

Case 2. Lesion in neck of astragalus four years after injury. Note radio-opaque zone of demarcation not seen in Figs. 1-A and 1-B.

ported by Dr. Pomeranz, showed "in the medulla of the fibula, approximately one inch above the epiphyseal line, a vacuolated area. The margins of this area are clean cut. There is a slight endosteal sclerosis, with distinct cortical and periosteal thickening. The periosteal thickening is deposited in layers parallel to the long axis of the shaft. The posterior surface of the fibula at approximately the same level also shows a parallel periostitis. The ankle joint proper is roentgenographically negative. *Conclusion:* Bone abscess, lower end of the fibula."

In the belief that we were dealing with a Brodie's abscess, the bone was exposed and several drill holes were made through the cortex for drainage. The wound was packed and a plaster-of-Paris bandage was applied. Within two weeks the patient was discharged to the Out-Patient Department. In spite of the fact that there was no question of pressure, the patient complained of severe pain. In June the patient was readmitted for examination of the so called osteomyelitis, and specimens removed at this time were reported by Dr. Jaffe as showing "osteoid masses in tumor formation. The lesion is entirely benign. *Diagnosis:* Benign osteoid-tissue-forming tumor."

FIG. 3

Case 3. Tumor of fibula taken upon admission for reoperation.

CASE 4. L. H., female, aged twenty, was admitted to the Hospital on December 4, 1933, with a history of pain and swelling in the terminal phalanx of the third toe of about one year's duration. There was no history of injury or of any acute infection. The pain was constant, dull, and boring in character; was worse during the night; was unaffected by exertion; and did not radiate. About two months before, the pain and swelling of the toe had become so severe that the patient was unable to sleep.

Examination disclosed a marked swelling of the distal phalanx of the third right toe (Fig. 4-A). There was no redness or discoloration of the toe, but the nail was discolored brown. There was marked tenderness on pressure over the terminal phalanx. The Wassermann was reported as negative. The roentgenogram (Fig. 4) showed what was reported as a sequestrum of the terminal phalanx of the third toe and a slight osteitis of the terminal phalanx, with a soft-tissue swelling.

Under local anaesthesia a horseshoe incision was made around the tip of the toe and the terminal phalanx exposed. To our great surprise no evidence of osteomyelitis was

found; but, at the tip of the phalanx, in the region where the annular sequestrum had been expected, there was a circular area of white, irregular bone, separated by a slight sulcus from the rest of the phalanx. The terminal half of the phalanx, including the involved area, was resected and submitted for pathological report. The healing was uneventful. The pathological specimen reported by Dr. Jaffe was as follows:

"*Gross:* Specimen consists of a fragment of bone. It was cut longitudinally. It shows a yellowish focus of changed bone. *Microscopic:* Section of the terminal phalanx shows a rather circumscribed focus of irregularly meshed bone, derived through rapid calcification of osteoid. This focus is sharply delimited from the rest of the original bone. The original bone shows a moderate hyperostosis on a reactive basis. The intertrabecular marrow is fiber marrow. There is periosteal new bone formation. *Diagnosis:* Medullary osteoid-tissue-forming tumor."

In all five of the cases here reviewed the clinical picture is characterized by a triad of signs which seem to be pathognomonic of the condition. These are pain, swelling, and the roentgenographic appearance of the involved bone. The pain, of a dull, boring character, is constant, and is worse at night and after exertion. The swelling is localized to the affected area and may or may not be associated with heat and redness of the overlying skin. These signs might well be present in other affections, and so may condone the erroneous diagnosis of Brodie's abscess, tu-

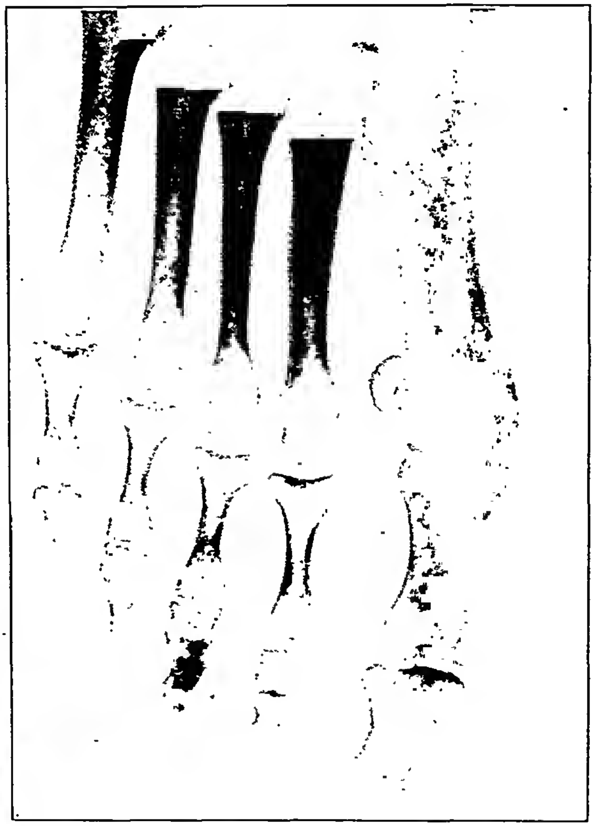

Fig. 4-A Fig. 4-B

Case 4. Note swelling of toe and discoloration of nail. The central zone is uniformly dense as compared with the central zone in Figs. 1 and 2.

Fig. 5

Case 4. Photomicrograph showing central area of calcifying osteoid tissue, sharply demarcated from surrounding bone to which it is connected by strands of osteoid tissue. Note also reactive hyperostosis in surrounding bone, with fibrous infiltration of marrow spaces. (× 25)

berculosis, or a sclerosing osteomyelitis, previously made. But in the light of our present knowledge, the possibility of any of these conditions can be almost positively excluded upon the basis of the roentgenogram alone, which is so typical that in itself it may be considered diagnostic of the osteoblastic or osteoid-tissue-forming tumor.

At first glance the appearance is similar to that of an annular or button-like sequestrum lying free in a cavity. Closer attention, however, is rewarded by the observation that there are several different parts to be considered. In the earlier stages of the condition, as observed in Case 4, and in the series of roentgenograms in Case 1, the central area is quite uniformly dense. As the lesion ages, this central portion seems to become subdivided into a peripheral annular zone of radio-opacity, surrounding a central lighter area which may represent the site of tumor necrosis. Beyond the central area there is a zone of radio-translucency, which is transversed by radially arranged opaque striations, which seem to unite the central area with the surrounding bone. This is the bone of osteoid tissue which, being calcium-poor, naturally offers but slight barrier to the

passage of the x-rays. Still more peripherally lies the normal bone which may be faintly outlined or which, as in Case 2, may be sharply demarcated from the zone of osteoid tissue by a dense circular shadow. At the outset, the lesion is localized definitely to the involved bone. As time goes on, the surrounding tissues seem to be involved in the reactive process. In Case 1, where redness and heat as well as swelling were noted, this process consisted of the deposition of newly formed, calcium-containing tissue, as well as of the infiltration of the flexor tendons.

In an earlier paper, Jaffe and Mayer [2] observed a tumor of a metacarpal bone, which they reported under the descriptive title of "Osteoblastic Osteoid Tissue-Forming Tumor". Somewhat earlier Bergstrand [3] had described two cases in which the histological appearance of the lesion was in all respects comparable to that observed by Jaffe and Mayer. (Dr. Jaffe exchanged slides with Dr. Bergstrand and they agreed on the similarity of the microscopic pictures.) According to Dr. Jaffe, slides prepared from tissue removed from Cases 2, 3, and 4 histologically resembled those from the metacarpal tumor. On the other hand, there were certain clinical differences between the earlier case and these which should be noted. The metacarpal tumor described appeared to be a very expansile and much more destructive tumor than those in the cases here reported. There appeared to be relatively slight pain associated with the growth of that tumor as compared with these and the x-ray picture, which is here quite characteristic, is not seen even in the earliest roentgenogram of the metacarpal tumor. It may very well be that these two pictures represent different clinical phases of the same pathological entity. On this point we do not feel justified in expressing any definite opinion, especially since the question of the entity and pathological nature of these tumors is at present engaging the attention of Dr. Jaffe.

From a medicolegal point of view, this condition presents another aspect of interest. Three of the cases here discussed gave a history of some sort of injury, usually a blow, antedating the onset of symptoms. If the injury were to be considered as etiologically related to the tumor formation, it could be expected that, with the lapse of time, a difference in the size or shape of the tumor would occur. In Case 1, where roentgenograms were made within six weeks of the alleged injury, there was no appreciable variation in the visualization of the annular shadow as compared with roentgenograms taken four months later, even though the rapid appearance of calcium-containing tissues about the original lesion indicated fairly active growth. On the other hand, in Case 2, where injury had taken place four years before the onset of symptoms, only very slight reaction is noted. It is our opinion that the injury is not to be related to the development of the tumor. At the most it may be admitted that the blow may have served to direct attention to minimal symptoms,—may indeed have accentuated symptoms, or even have been responsible for the initiation of the reactive process; but beyond this any contention would be extremely tenuous.

When we were under misapprehension as to the correct diagnosis, incision and drainage as for a localized osteomyelitis was justifiable. Since the true nature of the condition has been recognized, it must be realized that the only hope for cure lies in the complete eradication of the tumor and closure of the wound without drainage. Failure to proceed in this manner, as in Case 3, necessitated reoperation. The necessity for removal of the tumor becomes more urgent when it is recalled that the metacarpal tumor described by Jaffe and Mayer began to grow rapidly after some years. The possibility of malignant transformation exists, though it is not clearly established.

SUMMARY

A group of cases is presented in which diagnosis has not previously been made correctly. This condition is characterized by pain, swelling, and an unusual x-ray picture. The lesion appears to belong in the class of benign osteoblastic osteoid-tissue-forming tumors and should be treated by complete excision.

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OSTEITIS FIBROSA LOCALISATA OF THE PATELLA

BY RIGNEY D'AUNOY, M.D., AND JOHN H. CONNELL, M.D.,
NEW ORLEANS, LOUISIANA

From the Departments of Pathology of the State Charity Hospital of Louisiana and the Louisiana State University Medical Center, New Orleans, Louisiana

Lesions of the patella, exclusive of congenital deformities and those directly resulting from injury, are comparatively rare. Undoubtedly the rarest of patellar lesions is that clinical pathological complex spoken of as osteitis fibrosa localisata, of which only two recognized cases have been reported,—the first that of Cole [1] in 1925, and the second that of Faltin [2] in 1928.

We wish to record the third case.

A colored boy, sixteen years of age, gave a history of severe trauma to the right knee two years previous to examination. During the past nine months he had noticed some pain and definite limitation of motion of the right leg.

Examination revealed a markedly enlarged patella. No tenderness was present, but there was an associated lack of development of the muscles of the affected limb. Chemical examination showed the calcium and phosphorus levels and ratios of the blood to be within normal limits. The Wassermann reaction was negative. Roentgenographic examination revealed an irregularly shaped area of opacity in an expanded thin-walled patella, and a tentative diagnosis of giant-cell tumor was made. Further examination showed ununited epiphyses, indicative of youth, but no further cystic bone lesions were found. The patella was removed at operation.

The bone was enlarged and slightly irregular in shape. Sectioning showed a cavernous structure containing a brownish-red fluid with numerous trabeculae coursing through the hollowed medulla. These trabeculae consisted mainly of fibrous tissue, but here and there spicules of bone were noted. On the cortical surfaces there was a definite membrane which could be stripped away. Microscopic examination revealed the true nature of the lesion: there was a fibrous layer lining the cavity, and upon this membrane there occurred embryonic fibroblasts and true calcified bone spicules irregularly scattered. Areas of fresh and old hemorrhage were present. Fibrous bands intertwined and ramified throughout the cavity; occasional giant cells with from three to five nuclei were seen, especially in the areas showing the youngest fibroblastic tissue and fresh hemorrhage. Pigmentation, although present, was not significant.

DISCUSSION

The differential diagnosis between a solitary bone cyst (fibrosa cystica localisata), such as that just described, and a giant-cell tumor depends upon an understanding of certain clinical and pathological features of the two conditions. Over eighty per cent. of cases of osteitis fibrosa localisata occur in persons under twenty years of age, and involve the metaphyseal junction of the growing bone. It is our belief that the lesion has definite and direct connection with that transitory stage in true bone formation in which osteoblastic-osteoclastic activity is especially marked. Maximow [3] states that it is almost certain that osteoclasts produce a lytic ferment, for, where they come in contact with the surfaces of bone lamellae, the cells of

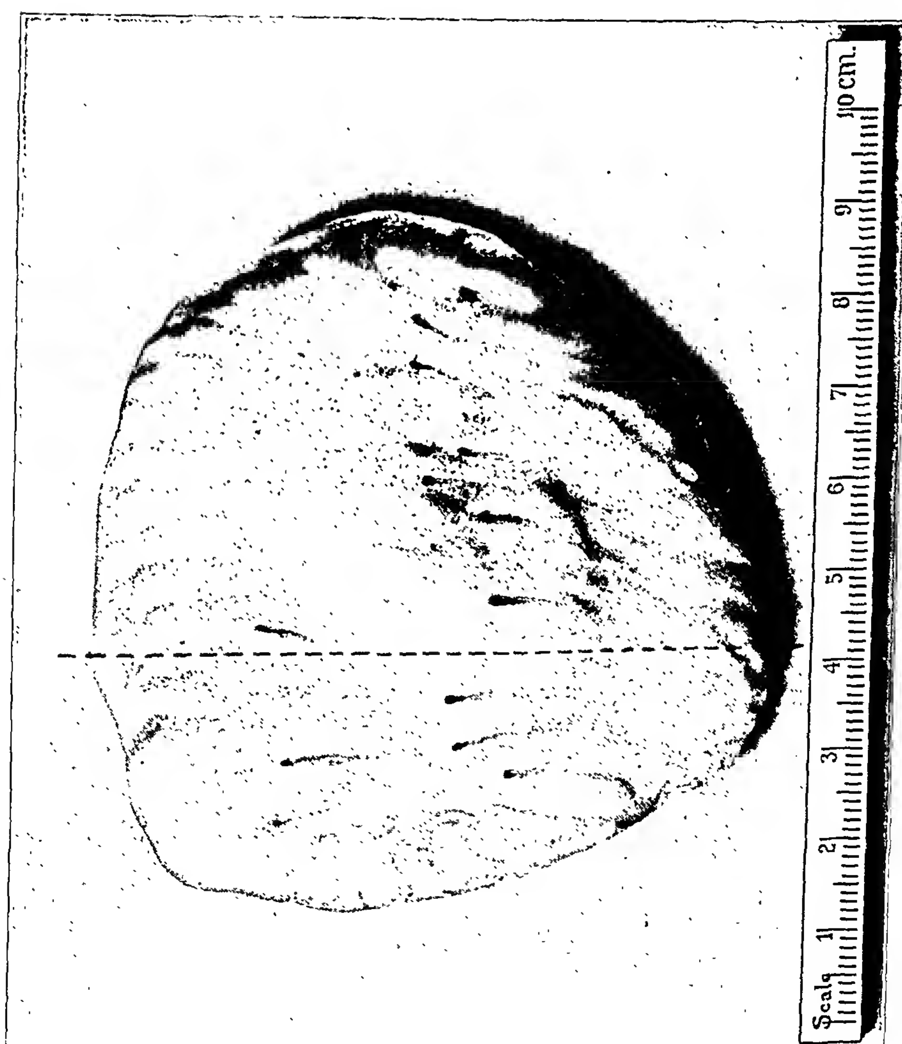

Fig. 1

Drawing of the patella showing enlargement and irregularity.

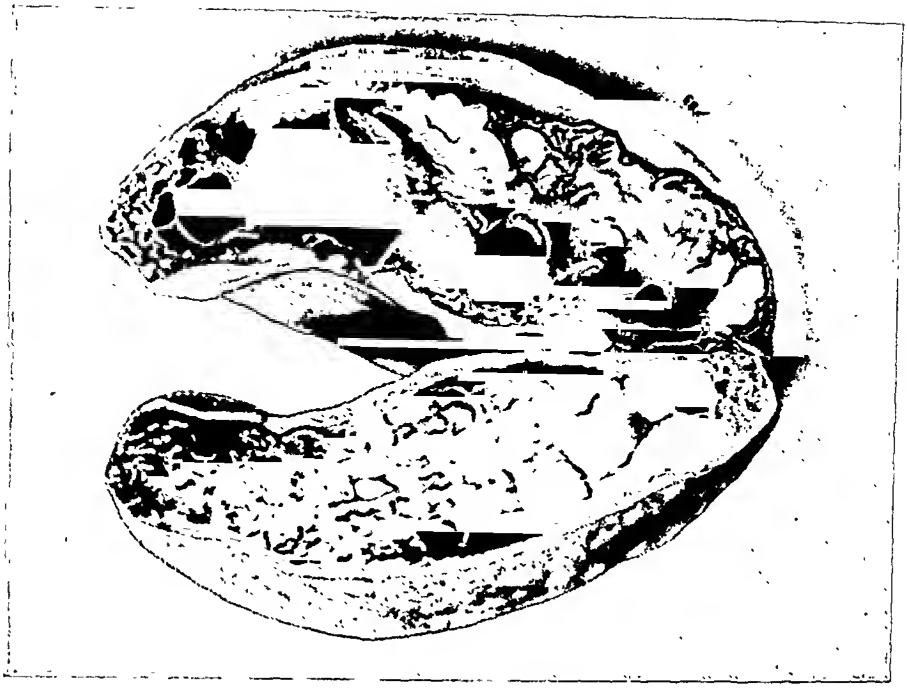

Fig. 2

Sagittal section through patella showing cavernous structure with numerous bone spicules.

the latter dissolve. Normally, ill understood natural forces keep in balance such potentially destructive processes. However, normal inhibiting influences are often hindered in a localized area either by toxins or by altered vascularity, frequently related to trauma. It is under these conditions that osteoclastic activity may result in cavity formation.

We do not agree with Virchow's original view-point that these cysts arise in degenerating chondromata. It is noteworthy in this respect that all case reports and pathological discussions of osteitis fibrosa stress the absence of cartilage. Later views, such as Bloodgood's [4], that low-grade infections are the basic cause, although possibly correct, have never been definitely proved, for, as in our case, cultures and animal inoculations have been uniformly negative. The attempts of some authors to correlate the localized cystic bone conditions, in some of their essential details, with diffuse fibrocystic disease of bone (von Recklinghausen), other parathyroid disturbances, and disorders of calcium-phosphorus metabolism in general hardly seem plausible. Repeated reports in cases of solitary bone cysts show normal blood calcium-phosphorus contents and ratios, and in only one instance in the literature have we found a solitary bone cyst followed in later life by other lesions far removed from the original lesion.

FIG. 3

Roentgenogram showing vacuolated expanded patella. Bony trabeculation is clearly shown.

Microscopic sections prepared from material secured in cases of any type of osteitis fibrosa show the reparative stage which is no different in essential details from any healing or protective reaction within bone. In every case a few scattered giant cells may be seen which at least closely resemble osteoblasts. As Geschickter and Copeland [5] point out, the persistence of the cyst in spite of the healing reaction is the result of nature's difficulty in collapsing its walls, and, when fracture or a crushing procedure at operation aids in bringing about such collapse, the lesion heals.

Giant-cell tumors of the bone occur later in life, when ossification is complete or nearly so. They are found in the epiphyseal regions of the bones and are nearly always located acentrically, usually causing pain at

Fig. 4

Photomicrograph showing fibrosis, new vascularization, and bone spiculization, with some lymphocytic infiltration. (× 220)

an early period in their development. In our experience, we have found that careful microscopic examinations of representative portions of such lesions reveal pictures fundamentally so different from that of osteitis fibrosa as to permit of slight chance of diagnostic error.

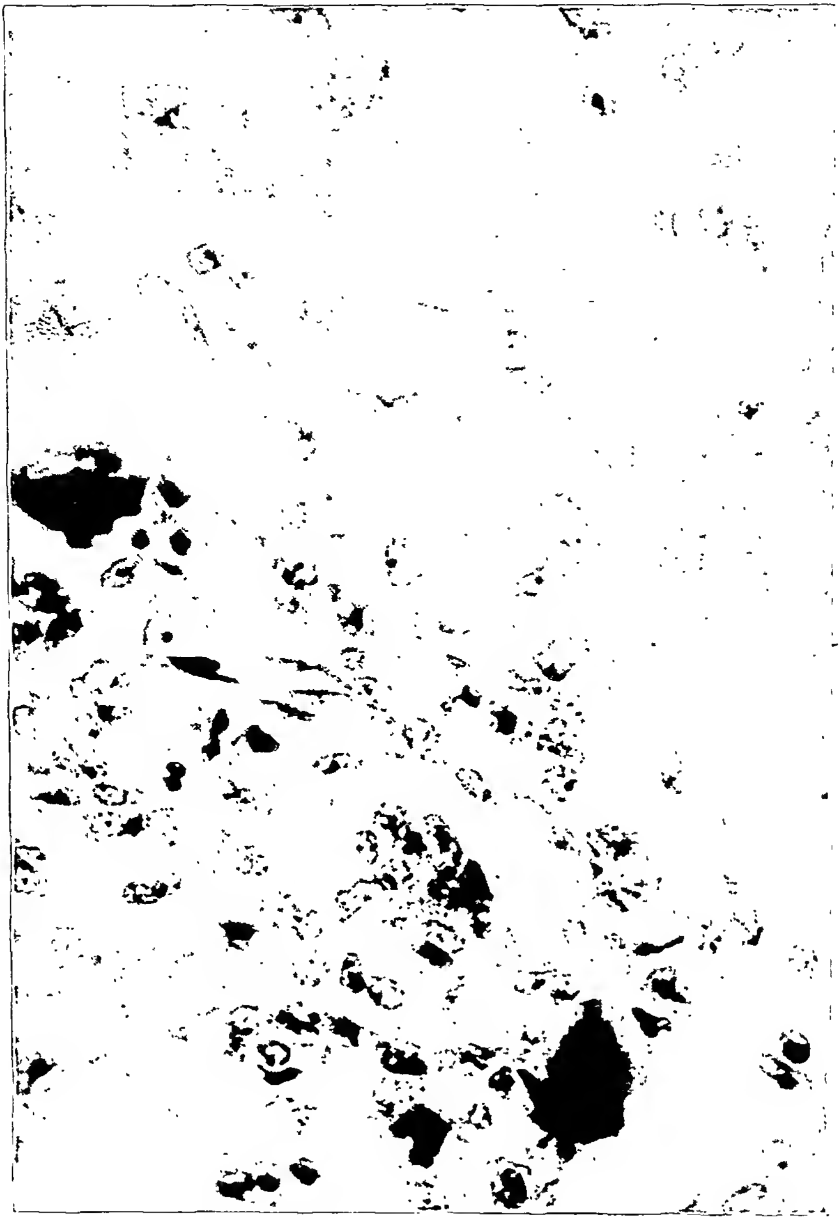

Fig. 5

Photomicrograph showing young fibroblastic tumor with interspersed giant cells. (× 440)

Radical procedure in cases of osteitis fibrosa is not indicated: curettement, or curettement with collapse of the cavity walls, and splintering of the bone in the diseased area result in complete cure in practically all cases.

CONCLUSIONS

A case of osteitis fibrosa localisata of the patella, the third on record, is here reported.

We believe osteitis fibrosa localisata to be a pathological complex, dependent upon altered osteoblastic-osteoclastic activity.

Conservative treatment is indicated.

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TREATMENT OF DISPLACED TRANSVERSE FRACTURES OF THE NECK OF THE RADIUS IN CHILDREN

BY ROBERT F. PATTERSON, M.D., KNOXVILLE, TENNESSEE

Operative removal of the head of the radius in children is seldom indicated, owing to the growth disturbance thereby produced. Effective methods of closed reduction are, therefore, of great importance, since practically perfect alignment of the fragments is necessary to insure smooth and painless rotation.

The method to be described is applicable only to complete fractures of the neck, or that portion of the radius between the head and the insertion of the biceps, with displacement, and possibly to epiphyseal separation. The annular or orbicular ligament must be intact.

The procedure is based upon the following anatomical facts: the head, which is button-shaped, is covered both on top and on the sides with cartilage and articulates with the capitellum or the radius, and laterally with the radial notch of the ulna. The head is tightly gripped by the annular ligament which surrounds it and binds it to the radial notch. It is firmly anchored to the humerus above by the strong external lateral ligament which is inserted into its fibers, especially before and behind, thus forming effective counterextension against traction. No muscles are inserted into the head and neck, and displacement cannot occur unless the annular ligament is torn. The supinator muscle, which arises from the ulna, below the radial notch, and passes around the posterior border of the radius, is inserted into the lateral border of the radius in its upper third, below the neck, and the biceps is inserted into the radial tubercle. Both of these muscles tend to displace the upper end of the lower fragment inward against the ulna and sometimes backward.

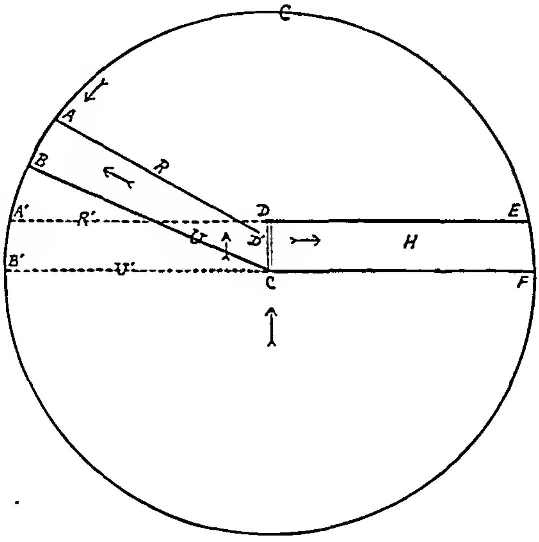

FIG. 1

Diagrammatic illustration of the mechanics of reduction. (See text for explanation.)

In order to reduce such a fracture, a force must be applied which will

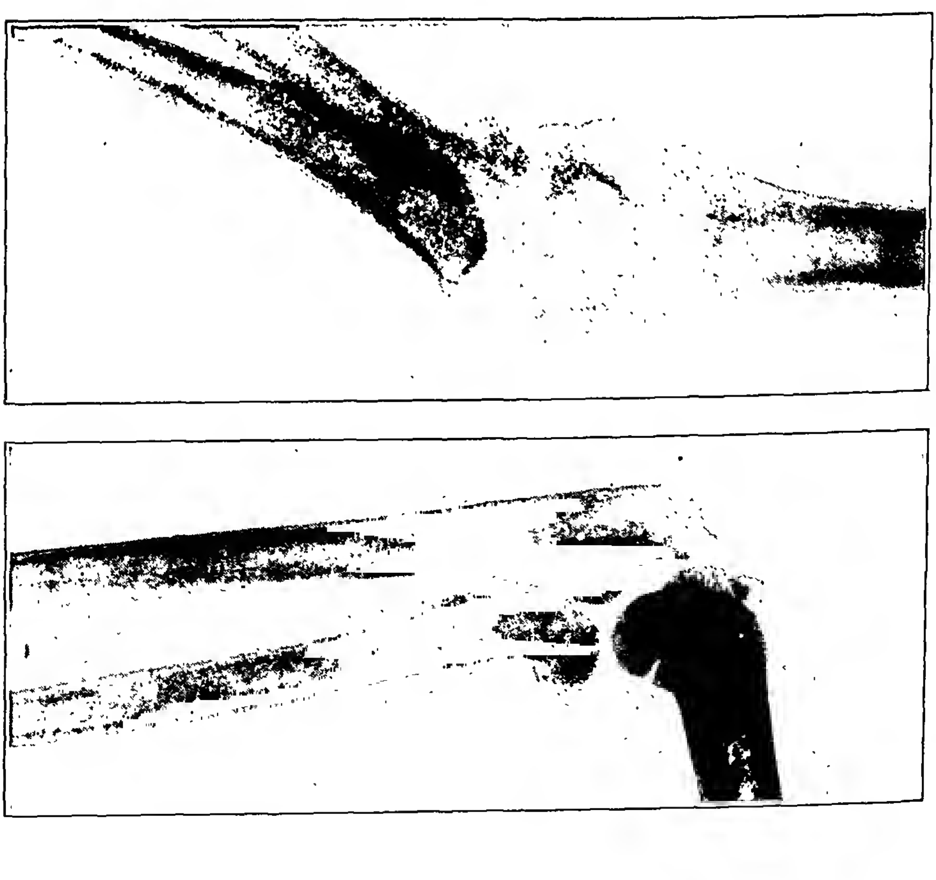

Fig. 2

Case 1, Louise F., injured April 14, 1932. Anteroposterior and lateral roentgenograms showing backward and inward displacement of the proximal fragment of the right radius upon the distal portion or head.

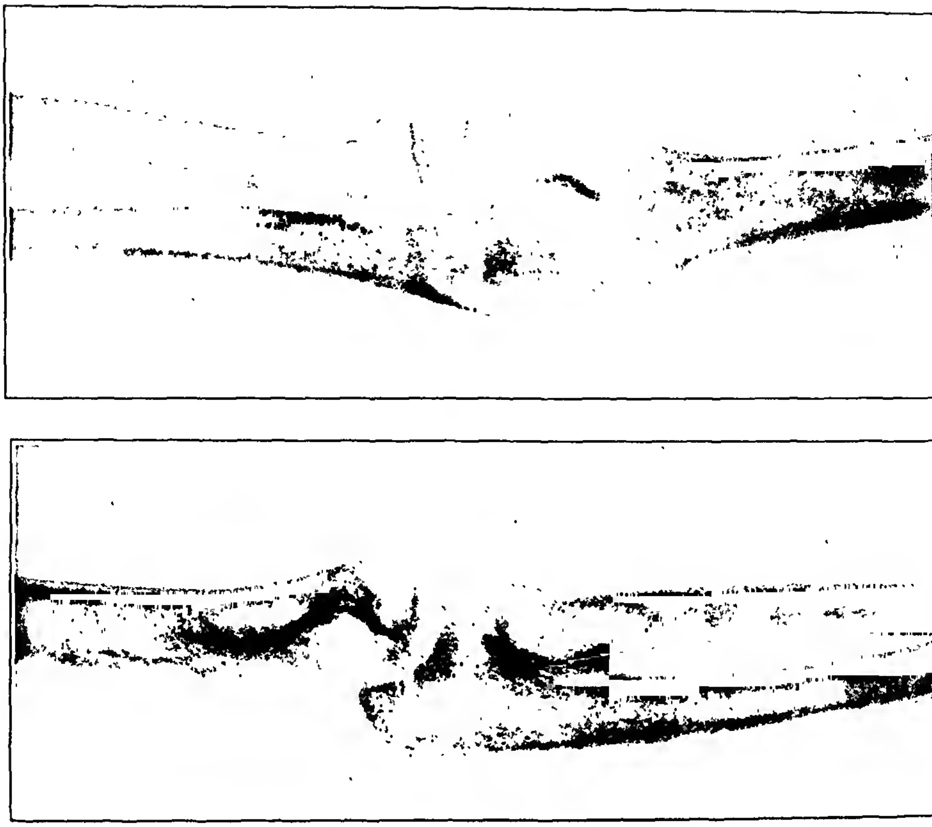

Fig. 3

Case 1. Roentgenogram taken immediately after reduction. Note restoration of alignment.

separate the fragments longitudinally, acting in opposite directions on the two portions of bone, but it must also force the upper end of the ulna outward to meet the fixed proximal portion or the head. These requirements are met in the following procedure:

An assistant grasps the arm and fixes the humerus, placing one hand against the inner condyle to act as a fulcrum for leverage. Another assistant uses traction on the arm and forces the forearm inward until the carrying angle is obliterated. He also supinates the forearm to relax the supinators. The position is checked by roentgenograms and, if the fracture has been reduced, a cast is applied with the arm in complete extension. The cast is worn two weeks and then removed, following which physiotherapy is instituted.

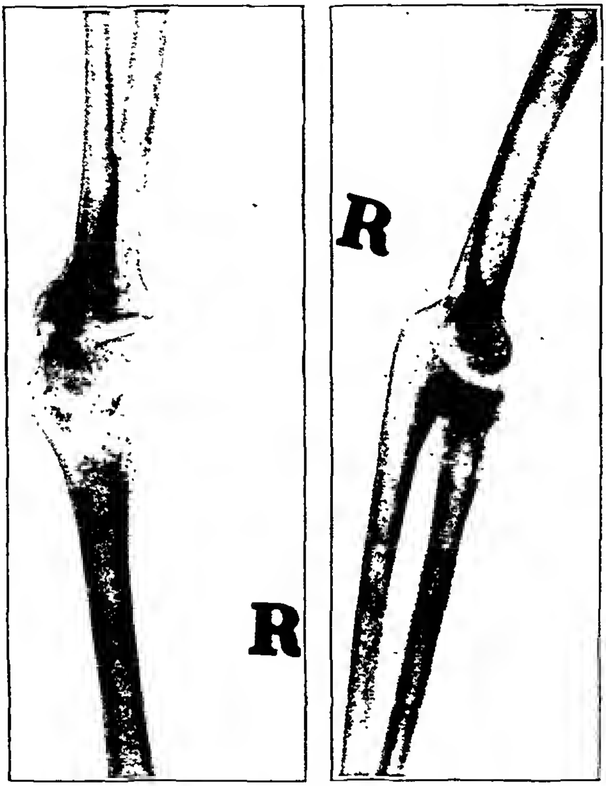

FIG. 4

Case 1. Roentgenogram showing the appearance of the bones in February 1934. Note the entire absence of any evidence of previous fracture.

The elasticity of the ligaments and other joint structures in children enables one to thus revolve the forearm inward on a vertical axis passing through the inner condyle.

The mechanics of reduction would seem to be as follows (Fig. 1): $AD'DE$ represents the line of the outer border of the arm, interrupted at the point of D' by a fracture. BCF represents the inner border with this line intact, but broken by the joint at point C. AD' is the radius distal to the fracture, with the upper end displaced inward by muscle pull. DE is the proximal fragment plus the humerus. BC represents the ulna. The humerus (H) being fixed, a sufficiently strong force applied against the wrist at A causes the forearm $ABCD$ to move to the position $A'B'CD$, thus obliterating the carrying angle of the elbow. The traction tending to straighten the line $AD'DE$, the leverage exerted against the fulcrum at C, and relaxation of the supina-

tors by complete supination of the forearm, all unite to overcome shortening and to force the displaced bone into proper alignment.

This method has been tried in two cases in children. In both instances reduction was satisfactory. We have not tried the method in adults. It would seem that the size of the limb, plus the comparative inelasticity of the ligaments and other soft tissues, would render the method inapplicable to adults.

In Case 1 the patient now has a perfectly normal arm in all respects, with the exception of ten degrees' limitation of flexion. The carrying angle is normal. Another child, a clinical patient, disappeared after the removal of the cast; consequently her present condition is unknown.

LOCALIZED ADHESIVE SPINAL ARACHNOIDITIS *

An Obscure Cause of Radiating Low Back Pain

BY JACOB KULOWSKI, M.D., F.A.C.S., AND WALTER SCOTT, M.D.,
IOWA CITY, IOWA

We wish to report a case of localized adhesive spinal arachnoiditis which was improved by operation, and to discuss briefly its pathological and clinical significance.

This disease has been referred to in the literature as intradural cysts of the spinal meninges, circumscribed serous spinal meningitis, leptomeningeal cysts, and, finally, it has been described by Stookey as localized adhesive spinal arachnoiditis.

Although pathological descriptions of arachnoid cysts appeared over seventy-five years ago, Munro states that pathologists questioned this lesion as a primary entity when he first discussed the subject in 1897. True leptomeningeal cysts have not been histologically demonstrated. However, the clinical syndrome of the localized and generalized forms of arachnoiditis was not appreciated fully until 1900, when Horsely, Krause, and others reported their findings. Spiller made the first surgical observation in 1903; his patient was still alive and well in 1909.

The original observers emphasized the fact that the symptoms of this lesion are those of a circumscribed compression of the spinal cord, and that the condition cannot be distinguished clinically from cord tumor. Little has been added to this conception despite the advances in diagnostic procedures. In particular there exists uncertainty as to the pathogenesis. It is remarkable that Stookey made a correct preoperative diagnosis of adhesive arachnoiditis in his last two cases. The chief factor in the differential diagnosis is a knowledge of this lesion. Fortunately, the brilliant results of the surgical treatment of tumor of the spine have justified early operative exploration. The relief obtained from exploratory laminectomy in arachnoiditis has been equally satisfactory. Recent reports of similar pathological conditions in the brain and cerebellum apparently furnish the key to heretofore obscure syndromes, such as migraine.

CASE REPORT

H. T., No. H 680, white male, aged thirty-two years, a barber, was first seen on February 2, 1933, when he complained of low back pain associated with bizarre widespread radiated pain of the abdomen and lower limbs, which had been initiated three months previously by heavy lifting. The history was suggestive of sacro-iliac strain, associated with sciatica. Conservative measures had failed to alleviate his symptoms. Further interrogation revealed a history of insidious low back discomfort of three years' duration, which appeared chiefly at night and which was relieved by active locomotion and

* From the Department of Orthopaedic Surgery, State University of Iowa. Service of Dr. Arthur Steindler.

FIG. 1

Anteroposterior and lateral roentgenograms of the dorsolumbar spine, following cysterna lipiodol injection. The saddle-shaped block is clearly depicted at the level of the tenth dorsal vertebra. This saddle-shaped deformity has been considered characteristic of tumor of the spinal cord.

the usual analgesics. Headache had been prominent since the onset of his present illness. He was becoming gradually totally disabled, and was confined to a wheel chair. In this position, he experienced some relief of pain and was able to sleep.

The past history also revealed that the patient had had three severe sunstrokes between the ages of fifteen and twenty years, periodic attacks of dizziness during his twenty-fifth year, and constipation. There was also a history of atypical asthmatic attacks and general weakness during adolescence. The family history was essentially negative.

Physical examination showed a well developed, adult, white male who did not appear to be acutely ill. Objectively, only moderate spasm and tenderness over the third and fourth lumbar vertebrae were elicited. All tests for sacro-iliac and lumbosacral disease were negative. The roentgenographic findings were not remarkable.

Despite a period of treatment with back support and physiotherapy, the condition persisted without remission, and, about one month later, the first neurological signs were noted: an absence of the abdominal and left cremasteric reflexes, and exaggeration of the deep tendon reflexes of the lower extremities. A slight left dorsal scoliosis was also evident, as well as a positive right La Guerre sign. Pronounced tenderness of the lumbar spine and a bilateral pitting oedema of both legs strongly suggested a destructive lesion of the spine. The patient now complained bitterly of widespread, lancinating, radiating low back pain, and was obviously in agony. Three months after the initial observation,

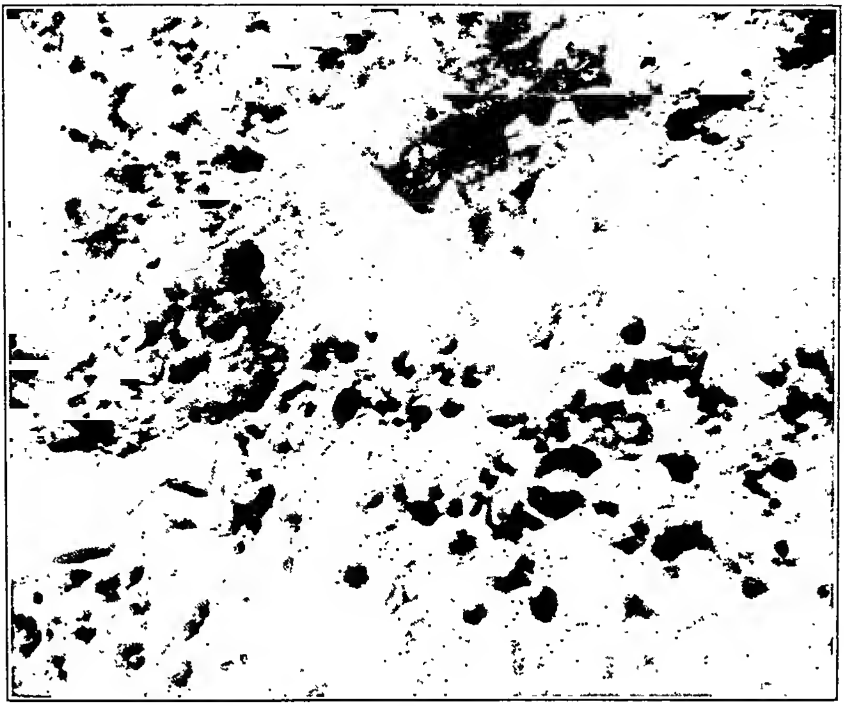

Fig. 2

High-power photomicrograph of the subdural tissue removed at operation. The lower area shows young fibrous connective tissue, containing a large number of polymorphonuclear leukocytes. The superficial layer of this tissue shows in part a layer of cells resembling the endothelial type. Most of the circumference, however, is surrounded by fibrinous exudate with a number of polymorphonuclear leukocytes and mononuclear exudate cells. The connection between the fibrous tissue and fibrinous exudate is very intimate, so there is no doubt that the fibrinous exudate is in the stage of organization. Sections of the ligamentum flavum, the dura, and the bony laminae did not show any remarkable pathological changes. Cultures from the tissue and the spinal fluid remained sterile.

he had noted some spasticity of the feet during plantar flexion, marked constipation, and difficulty in urination, but no other motor or sensory disturbances.

Repeated examinations elicited some neurological evidence of spinal-cord localization. The deep tendon reflexes were exaggerated and associated with bilateral ankle clonus and Babinski signs, but no objective muscular weakness or sensory disturbance were demonstrable. The examination of the spinal fluid showed typical Froin's syndrome; all other pertinent laboratory tests were negative. Cysterna injection with lipiodol revealed by roentgenogram a definite saddle-shaped block at the level of the tenth dorsal vertebra. The check-up fluoroscopic examination showed that the block level remained unchanged. The tentative diagnosis was tumor of the cord at the tenth dorsal vertebra or at the twelfth segment of the cord. Exploratory laminectomy was indicated.

On May 5, 1933, under ethylene anaesthesia, a laminectomy was performed from the ninth dorsal vertebra to the first lumbar vertebra inclusive. The dura did not pulsate until all of these laminae had been removed, and up to this point the extradural passage of the exploratory probe was obstructed. The probe could now be passed easily up and down the canal. The dura was carefully opened at the mid-line, and was found to be thickened, as were the underlying membranes. The leptomeninges were opaque and adherent to the dura, thus obliterating the subdural and subarachnoid spaces. When the subdural tissues were incised, there was a generous gush of clear spinal fluid from above

this level. Adhesions were separated as far as possible, and the entire field was freed of constricting bands. The cord showed no evidence of tumor. The dura was closed with fine interrupted silk sutures. Drainage was not considered necessary because the entire pathological picture was clearly that of a chronic inflammatory nature. The rest of the wound was closed with interrupted catgut and the skin with dermal sutures. The patient was returned to his room in excellent condition.

The immediate postoperative convalescence was uneventful. There was the usual disturbance of the bladder lasting for three days, which required catheterization. Enemata were necessary for about three weeks until bowel control returned. The temperature rose abruptly to 105 degrees Fahrenheit and remained above 103 degrees for several days after the operation, unaccompanied by any constitutional reaction, and could not be explained. The wound healed by primary intention.

Severe nocturnal pain persisted for several months, necessitating the administration of morphine, but the patient was active three weeks after operation, and the dependent oedema gradually subsided. The patient is ready to return to his occupation at the time of writing, February 1934.

There remains a residual exaggeration of the deep tendon reflexes, but no persistent clonus or Babinski signs. Most gratifying is the absence of all spontaneous pain and local back tenderness. The gait, which had been slightly ataxic after operation, is normal. However, there remains some degree of residual, postoperative, subjective sensory changes. There is a twenty per cent. loss of reaction to cotton in the right lower extremity. Pallesthesia shows a twenty per cent. loss on the right side, but none on the left. Two-point discrimination is slightly impaired on the right side and is normal on the left. Pain and thermal sensations are decreased about fifty per cent. on both sides. Proprioceptive sensation in the great toes is normal. All of these findings refer to the lower limbs up to the level of the umbilicus.

This case is interesting from a clinical and pathological view-point. It is becoming more and more evident that a most careful evaluation of low back pain, associated with radiated pain, is imperative. The "sciatic syndrome" is a symptom complex which has been and still is causing confusion as to its clinical conception. Radiating pain is a prominent feature in the great majority of cases of low back pain seen by the orthopaedic surgeon. The intraspinal source of much of this obscure radiated pain is being more and more emphasized. A clinical classification is helpful and urgent in the evaluation of this symptom which will remain for the most part a clinical one. The following classification is both practical and direct:

1. *Idiopathic or Mechanical:* There is evident an underlying involvement of the osseo-arthritic structures or their adjacent soft parts, alone or combined. Where there are no neurological signs of impairment of the lumbosacral root or nerve, the cause is a mechanical one. Those conditions which present objective signs, pointing to involvement of these roots or nerves, are considered as radiculitis or neuritis.

2. *Symptomatic:* The sciatic syndrome is an early and prominent feature of the clinical picture. The underlying cause may be neoplastic, inflammatory, vascular, or degenerative diseases of the spine, pelvis, cord meninges, roots, or nerves in this area.

3. *Neuralgic:* This group is surely very rare and, at best, ques-

tionable, but one may, with certain reservations, include in it instances of paroxysmal lancinating pains in the low back without organic neurological signs and without evidences of involvement of the regional bony or soft parts.

Even this analysis accentuates the diagnostic difficulties encountered. Nothing can replace a careful and complete physical examination. Despite the almost innumerable sources of the symptoms under discussion, the orthopaedic surgeon must, above all, determine whether or not the patient belongs in the mechanical group. This can be accomplished by direct examination. It is useful to employ Steindler's four cardinal diagnostic points for the positive determination of low back pain: tender-point localization, position of relief, position of aggravation, and relief following immobilization. It is also apparent that, in the more obscure instances, the diagnosis of low back pain requires the enlistment of the entire field of medicine. Finally, there is localized adhesive spinal arachnoiditis, which is almost impossible to differentiate definitely. Peculiarly enough, the generalized forms give rise to practically the same symptoms as the localized variety, although a greater degree of cord degeneration will follow in the former, if not relieved. In this case, only after a period of prolonged observation was it possible to determine the final localization of the underlying pathology.

Early operation may prevent a secondary transverse myelitis and subsequent cord degeneration. While it is difficult to differentiate this lesion from cord tumor, the outstanding motor disturbances may suggest the basic cause. Disturbances of the bladder and rectum occur late in the evolution of this condition, and are not usually complete. The following characteristics have been quite constantly observed: long duration of symptoms, extremely slow evolution of symptoms, wide distribution of pain not corresponding to a root area, and Froin's syndrome.

The etiology and pathology of this lesion have been doubtful and controversial. The pia and arachnoid are liberally supplied with blood vessels (Macewen), which enhances the possibility of a primary inflammation. Because of the frequency of inflammatory adhesions in other serous cavities, it is reasonable to expect similar sequences in the delicate meninges, as a result of either septic or aseptic inflammations. The pathological findings in this case indicate a primary, non-specific, localized, inflammatory lesion of the arachnoid, probably of embolic origin, and this case is presumably the first to substantiate this claim. It is well known that such a condition may be secondary to trauma, tuberculosis, and lues. The subdural spaces should be explored in all cases subjected to laminectomy because of paraplegia.

ARTHROTOMY AT THE KNEE—POSTERIOR INCISION

BY ARMIN KLEIN, M.D., BOSTON, MASSACHUSETTS

The approach to the knee joint offered below is by the posterior route. It differs only slightly perhaps in position from other approaches reported previously by Brackett and Osgood[1], Henderson[2], and others; but it has an advantage over these incisions in that it is the most direct posterior route to the internal posterior compartment of the knee joint, passing through natural planes of cleavage, and necessitating a minimum amount of dissection in an area free from important blood vessels and nerves. From its location it allows free access to, widest exposure of, and above all, dependent drainage from, the internal posterior compartment of the knee joint, when the patient is lying in the usual supine position.

For this approach an incision about four inches long is made over the internal side of the posterior aspect of the knee joint (Fig. 1-A). The incision runs parallel with the long axis of the leg and is just external to the semitendinosus muscle. The center of the incision is over the knee-joint line. The subcutaneous fascia is incised, and the incision is deepened by blunt dissection in the plane between the semitendinosus and the inner head of the gastrocnemius muscles (Fig. 1). These muscles are retracted to expose the fascia and fat over the internal femoral condyle. The fascia and fat are incised and retracted, thus exposing the capsule of the knee joint. Up to this point, the exposure gained is limited internally and superiorly by the borders of the semitendinosus and semimembranosus muscles. The lower end of this incision extends down to the superior border of the popliteus muscle. The capsule is then opened by a longitu-

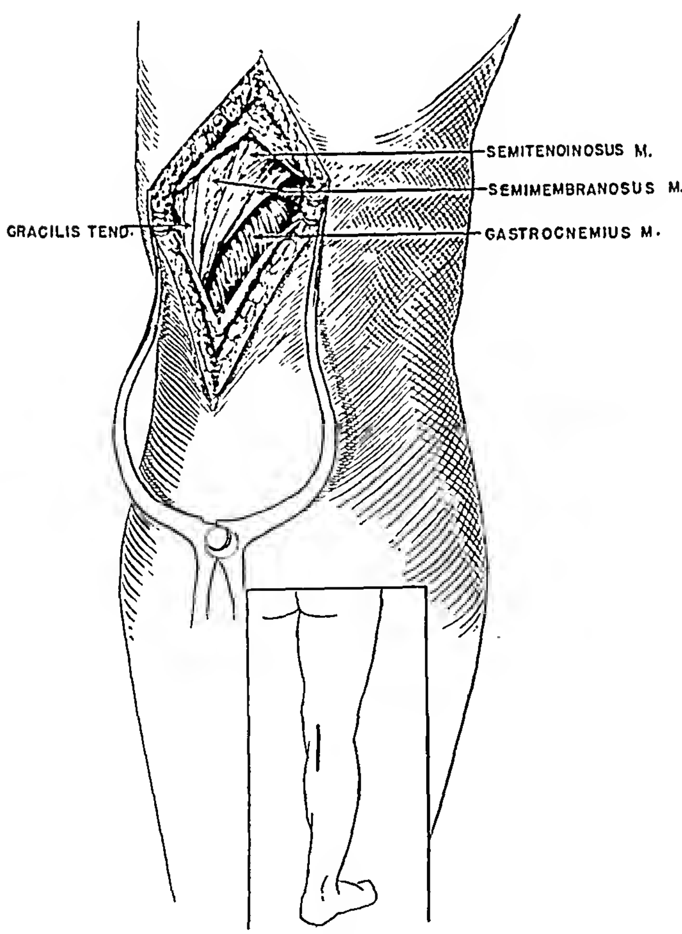

FIG. 1 FIG. 1-A

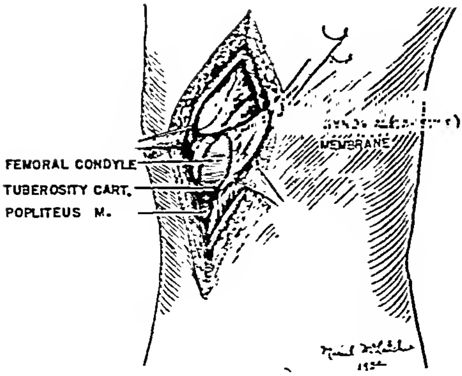

Fig. 2

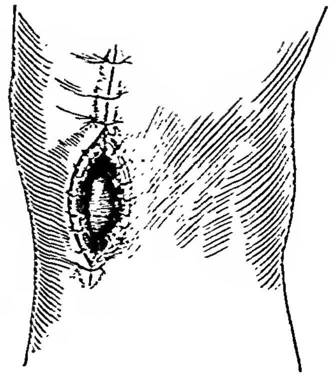

Fig. 3

dinal incision in the same line as the skin incision. The synovial membrane lining the posterior chamber is incised, thus exposing the cartilaginous surface of the tibial tuberosity (Fig. 2).

In cases of suppurative arthritis, the synovial membrane and capsule are sutured to the subcutaneous fascia with interrupted chromic catgut sutures. This effects a wide exposure of the posteromedial articular chamber. The muscles are enclosed and walled off within the reflected synovial membrane and fascia (Fig. 3). A cigarette drain may then be inserted into the cavity and held by a silkworm-gut stay suture. The skin incision above and below the resulting funnel-like cavity is approximated with interrupted silkworm-gut sutures.

Another paper, dealing with the specific utilization of this approach in draining suppurative arthritis of the knee joint, is now in course of preparation by the author.

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LUMBOSACRAL FACETECTOMY FOR RELIEF OF SCIATIC PAIN

A Case Report

By C. L. Mitchell, M.D., Detroit, Michigan

From the Division of Orthopaedic Surgery, Henry Ford Hospital, Detroit, Michigan

Recent articles by Ghormley, Williams, and others have drawn attention to the importance of the articular facets in the production of sciatic pain. Although Putti described this syndrome in 1927 and recommended operative removal of the facets in certain cases, we have no record of a similar operation in this country prior to Ghormley's report in 1931.

That this operative procedure offers a means of relief from sciatic pain in selected cases has been shown conclusively by the case reports of the above authors. Impingement of the fifth lumbar nerve in the lumbosacral intervertebral neural foramen should be suspected in all cases of sciatic pain that have not responded to adequate conservative treatment. Danforth and Wilson have pointed out that a disproportion exists between the fifth lumbar nerve and the lumbosacral foramen. Thus it follows that nerve irritation can occur with pathological conditions of the foramen and especially of the lumbosacral articulations which form the roof of the canal. Putti has placed emphasis on vertebral arthritis as a causative factor. Williams and Yglesias, and Ayers have demonstrated the relation of sciatic pain to narrowing of the lumbosacral disc and consequent reduction in size of the intervertebral foramen. Ghormley has recently described the "facet syndrome", mentioning in addition the possibility that fractures of the facets produce sciatic pain.

Operation should not be resorted to until after conservative treatment has been given a thorough trial. Care should be taken to exclude lumbosacral tuberculosis, spinal-cord tumor, or metastatic tumor involving the lumbar vertebrae, as these conditions may present a very similar clinical picture.

The following case is reported as it further illustrates the efficacy of this operative procedure:

Mr. T. A., aged thirty, was admitted to the Henry Ford Hospital on July 13, 1933, complaining of low back pain and sciatica. There was a history of intermittent attacks of "lumbago" during the previous four years. The onset of symptoms had always been quite sudden, usually having been precipitated by a quick stooping movement. He had been disabled for over two months with such an attack and during the month previous to admission he had noticed severe radiating pains down the posterior aspect of the left thigh and calf to the foot. Treatment had consisted of physiotherapy, vaccine injections, supportive belts, and osteopathic and chiropractic adjustments. During the past three years he had lost thirty pounds in weight.

Examination revealed findings characteristic of sciatic scoliosis. There was a

contralateral list of the spine to the right, with a right dorsal left lumbar scoliosis. The lumbar spine was flattened and muscle spasm was quite pronounced. Lasègue's sign was positive on the left side. There was loss of the left gluteal fold and atrophy of the thigh and calf. The left patellar reflex and ankle clonus were not obtained even with reinforcement. There was a suggestion of hypaesthesia over the dorsum of the left foot, but this was not definite.

Lateral roentgenograms of the lumbar spine showed narrowing of the posterior portion of the interspace between the fifth lumbar vertebra and the sacrum.

Treatment at first consisted of rest in bed on a firm mattress with daily baking and massage of the back and left hip.

On July 21, under general anaesthesia, the left sciatic nerve was stretched. No improvement was noted following this procedure.

On July 25, a plaster hip spica was applied because of continued sciatic pain. This was bivalved on August 2 and physiotherapy was continued. A sacro-iliac belt was applied and the patient was discharged on August 9.

On August 28, he was readmitted to the Hospital. Lumbar puncture, including Queckenstedt's test, revealed no abnormalities. Neurological examination by Dr. G. O. Grain revealed weakness of the left tibialis anticus, peronei, and extensors of the toes. In addition, there was muscle atrophy, absence of the deep tendon reflexes, and slight sensory changes in the foot. The diagnosis was sciatic neuritis, left side, with no evidence of pathology of the spinal cord. Patient was discharged on September 2.

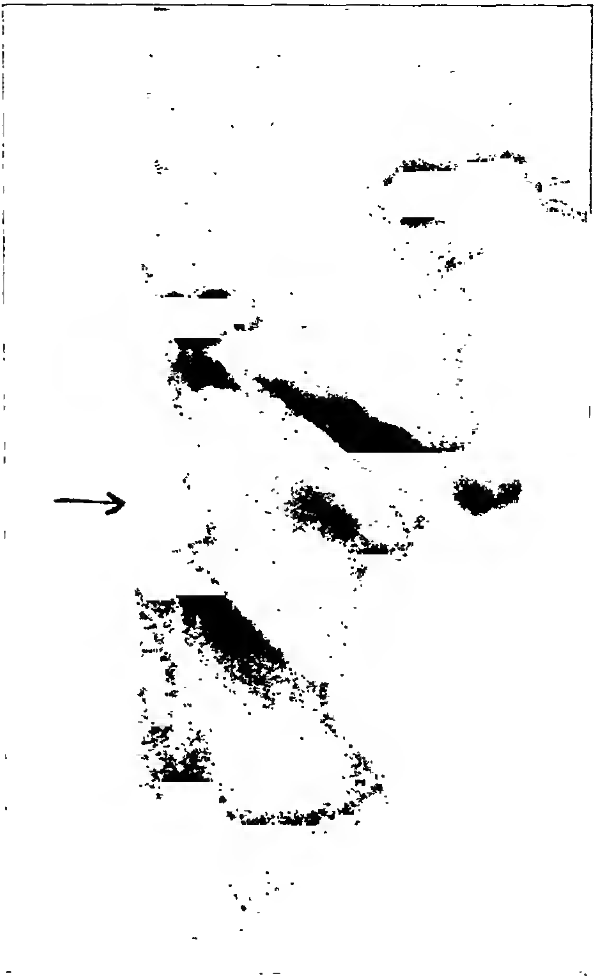

Fig. 1

Lateral view of lumbosacral spine. Note posterior narrowing of lumbosacral disc, subluxation of facets, and closure of foramen.

On September 14, the patient was readmitted by ambulance. The pain in the left leg had become unbearable and the patient had continued to lose weight. He was placed in bed with Buck's extension to both lower extremities and received diathermy to the left thigh daily. Epidural injection of novocain was done by Dr. A. S. Crawford on Septem-

ber 22 and repeated on September 30, without improvement in symptoms. A check-up neurological examination by Dr. Grain on October 13 revealed increased muscle weakness and definite sensory changes over the dorsal and lateral aspects of the left foot. A diagnosis was made of impingement of the fifth lumbar nerve at the intervertebral foramen.

An operation was performed on October 18. A curved incision, about six inches in length, was made from the level of the third lumbar vertebra just to the left of the midline, curving gradually downward and laterally. The erector spinae muscle was dissected subperiostially from the spinous processes, laminae, and sacrum, and retracted laterally, exposing the lumbosacral articular facets. These facets were removed with an osteotome and rongeurs, exposing the fifth lumbar nerve which was found to lie in close proximity to the anterior surface of the sacral facet. A Hibbs fusion of the lumbosacral spine was then done and the wound was closed in layers.

The day following operation the patient reported complete relief from sciatic pain. Convalescence was uneventful and on December 16 he was allowed up wearing a Goldthwait back brace. A check-up neurological examination, three months after the operation, revealed a full return of motor and sensory functions of the left lower extremity.

The patient experienced no further pain in the back or extremity and returned to work on February 1.

SUMMARY

A case is reported of sciatic pain, due to impingement of the fifth lumbar nerve in the intervertebral foramen, which was successfully treated by facetectomy and lumbosacral fusion.

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A MODIFICATION OF SKELETAL TRACTION IN FRACTURES OF THE LONG BONES

Report of Three Cases *

BY WILLIAM H. BAILEY, M.D., OKLAHOMA CITY, OKLAHOMA

When the usual apparatus for skeletal traction is applied, the patient is confined to bed for from three to four weeks. The object of the modified splint described in this paper is to make the patient ambulatory at a much earlier stage, and to aid in a more complete reduction at the first sitting. In the treatment of compound fractures especially, this splint

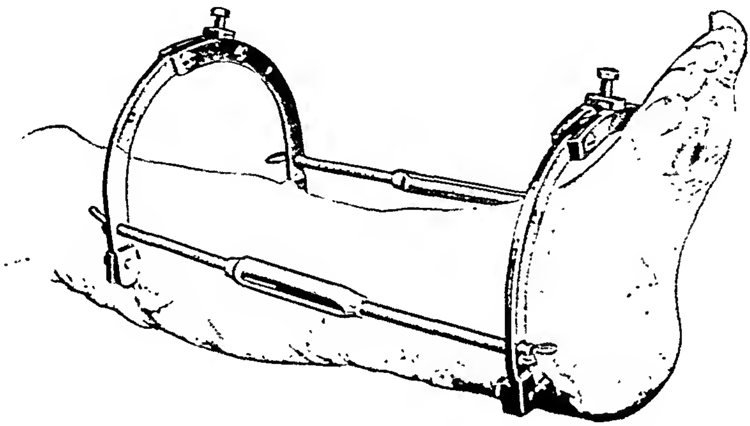

Fig. 1

Splint in position with cast applied, just before bows and turnbuckles are removed.

affords an almost ideal method of fixation, as there is an open space entirely around the limb so that the dressings can be changed easily and without interfering with the position of the fragments.

The splint (Fig. 1) consists of two Kirschner bows with wires or Steinmann pins connected at the sides by two turnbuckles, so placed that the bows can be strongly pushed apart.

The application of the splint is best accomplished with the patient under a general anaesthetic. In some locations, and with some patients, a local anaesthetic may prove satisfactory.

The fractured limb is placed in a position as near normal as possible. With the aid of an assistant, or of some temporary pulling device, strong traction is exerted on the distal fragment to overcome as much of the shortening as possible. The two Kirschner wires, or Steinmann pins, are now introduced at right angles to the bones and at a distance from each other just equalling the length of the turnbuckles when they are screwed up to their shortest lengths. The wounds in the skin at the points of

* From Wesley Hospital, Oklahoma City, Oklahoma.

entrance and exit of the wires are protected by placing small squares of sterile gauze around the wires and fastening them with a strip or two of adhesive plaster. If the wires or pins are too close together, the turnbuckles cannot be placed between the bows after they are in place. If the wires are too far apart, the turnbuckles, after the bows are in place, may not extend far enough to disengage the fragments and to permit proper alignment. The Kirschner bows are now fastened in position on the two wires and the wires tightened, so as to put them on tension. The two turnbuckles are next fastened in position between and on the sides of the bows, near the wires. As the turnbuckles are screwed out or lengthened, the proximal and distal fragments of the fracture are slowly pushed apart. When a sufficient separation has been secured to permit the ends of the fragments to become disengaged, the fragments usually drop into fair alignment of their own accord. The positions of the fragments are now checked by fluoroscopic examination and, if not satisfactory, further adjustment is made by manual manipulation and by changing the amount of push exerted, first by one turnbuckle and then by the other. When the proper alignment has been obtained, the turnbuckles are unscrewed a little, permitting the ends of the bones to come back into firm contact with each other. Sufficient extension, however, is maintained to prevent the subsequent muscle spasm from pulling the fragments out of line.

After satisfactory reduction has been secured, and if injury to the skin and soft parts does not contra-indicate, a plaster cast is applied at once. This cast incorporates both of the Kirschner wires, but the bows and turnbuckles are not included. Usually, this cast extends some distance above and below the site of the fracture, although it is not always necessary to immobilize the joints proximal to the splint. After the cast has set and dried, and if proper reduction has been retained as shown by the roentgenogram, the bows and turnbuckles are removed and the wires are held in position by the cast. The ends of the wires may be turned down or cut off and covered by a few turns of a bandage.

Occasionally, it is impossible to get sufficient extension to permit proper reduction at the first visit. In such instances, the splint is left in position, with strong extension exerted by the turnbuckles, and at frequent intervals a few turns of the turnbuckles are made until such time (frequently within a day or two) as the fragments are separated sufficiently to disengage the overlapping. Then the reduction is completed as before.

This splint is not applicable to fractures of the upper third of the femur or humerus, as there is not sufficient space to place the upper wire through the proximal fragment in a satisfactory position.

CASE REPORTS

Case 1. Mr. S., a middle-aged man, was injured in an automobile accident. He suffered a fracture about the middle third of the radius and ulna of his left forearm. A preliminary roentgenogram showed some comminution, with overriding of both bones. Pins were introduced above and below the fracture, and the two bows with turnbuckles

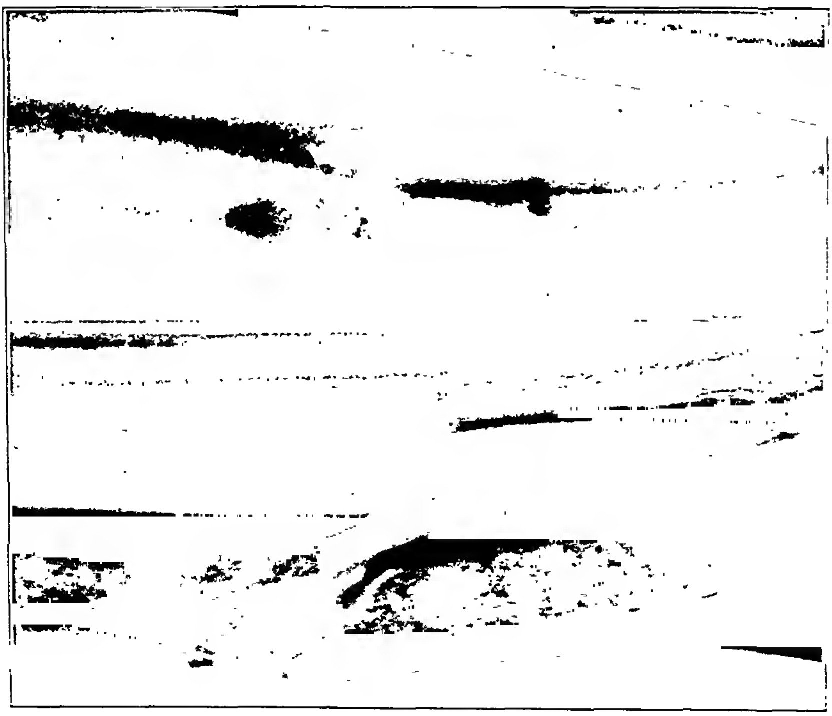

Fig. 2

Case 2. Anteroposterior and lateral roentgenograms on day of admission.

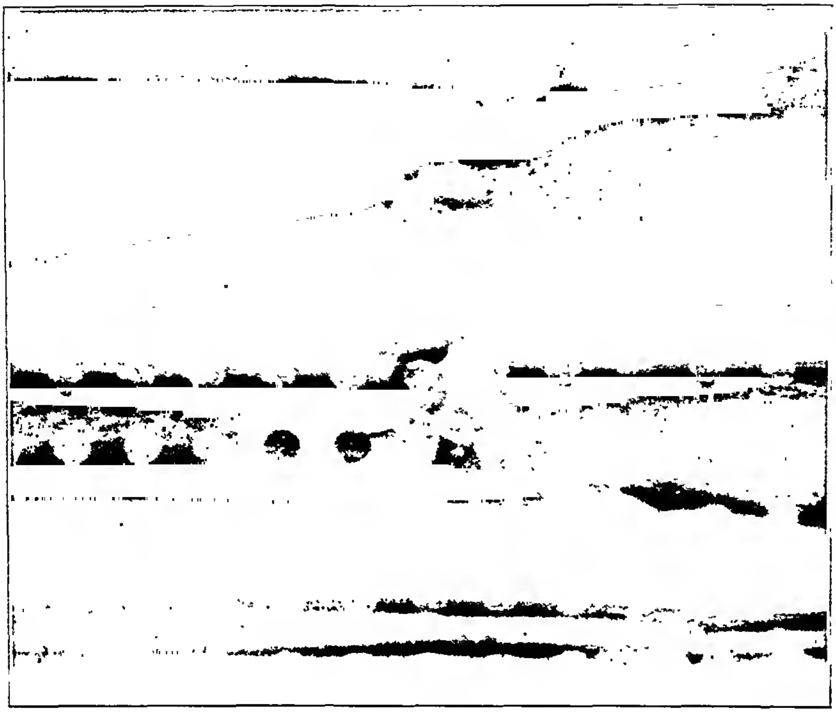

Fig. 3

Case 2. Anteroposterior and lateral roentgenograms after cast, wire, and pin had been removed and the leg had been put in a metal splint.

were attached. The splint was left in position with rather strong extension for two or three days.

Further adjustment was then made and a plaster cast was applied. The bows and turnbuckles were removed when the cast was dry. The patient returned to his work in a packing house in about ten weeks.

CASE 2. W. S., a boy of sixteen years, was also injured in an automobile accident. He suffered a compound comminuted fracture of the lower third of the tibia and fibula of his right leg. Figure 2 shows the position of the fracture when the patient was admitted to the hospital. The splint was applied and the fracture reduced. The wound was dakinized for about a week and then the patient was allowed up in a wheel chair. As soon as the wound healed sufficiently to require a dressing every other day only, a shell cast was applied, the bows and turnbuckles were removed, and the patient was allowed to go home on crutches. Figure 3 shows the position of the fragments when the cast was removed and the leg put in a posterior aluminum splint.

CASE 3. Mrs. D., a woman about fifty-five years of age, was injured by a fall in her home. She suffered a comminuted fracture of both bones of the lower leg, involving the ankle joint, and a posterior dislocation of the astragalus. So much of the articular surface of the tibia was broken off that an attempt to reduce the dislocation and hold it in position by a plaster cast failed. The extension splint was applied and reduction was obtained. The roentgenogram taken at this time showed too much joint space and a narrowing of the width of the joint; therefore, the tension was reduced sufficiently to permit the foot to come up into better position. After two days, a cast was applied, the bows and turnbuckles were removed, and the patient was sent home. This case is still under treatment, so final results cannot be shown.

CONSERVATIVE TREATMENT FOR COMPLETE DISLOCATION OF THE ACROMIOCLAVICULAR JOINT*

BY AARON H. TRYNIN, M.D., BROOKLYN, NEW YORK

In a recent publication Schneider[1] reported his method of autoplastic reconstruction of acromioclavicular dislocations with the use of fascia lata. An open operation, followed by immobilization in a Dillehunt plaster for six weeks, is the method advocated. Full function, he states, should be recovered in six months. Two cases are reported,—the first patient was seen seven weeks after injury and an operation was performed nine weeks later; the second patient was operated on two days after injury.

In this type of dislocation there is a tearing of the acromioclavicular and coracoclavicular ligaments, the degree of dislocation depending on the extent of the tear. In a previous communication,[2] the author described in detail the Böhler clavicular splint and demonstrated that, by adequate immobilization with the use of this apparatus, it was possible to obtain a healing of the partially torn ligaments and a restoration of the acromioclavicular joint in a case of incomplete dislocation. This was accomplished with a minimum of discomfort to the patient. Since then, the writer has had occasion to apply the same method of treatment to a case of complete dislocation of the joint, with an excellent result.

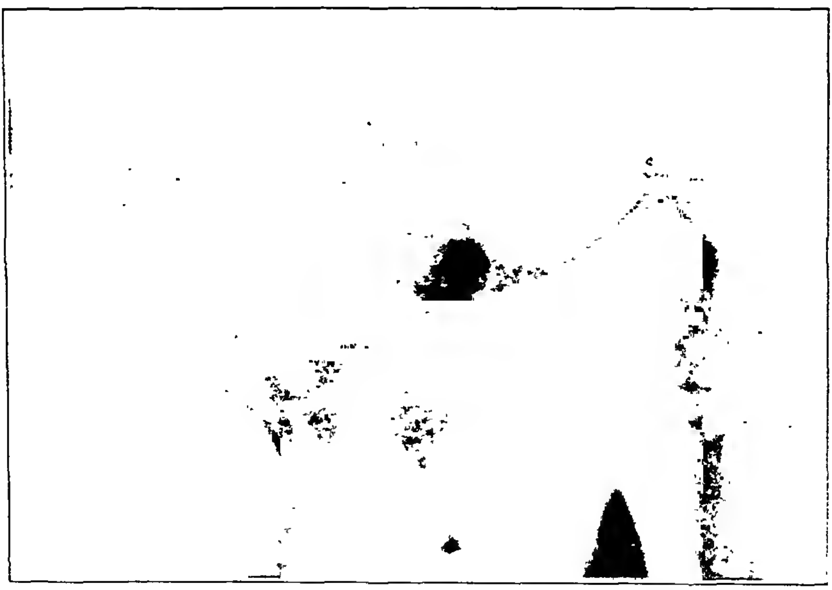

FIG. 1

Roentgenogram before reduction.

* From the Service of Dr. S. Kleinberg, Hospital for Joint Diseases, New York, N. Y.

Fig. 2

The clavicular splint applied, holding the clavicle in place.

Provided the treatment is instituted early, an open operation is not necessary. The advantages of conservative treatment over an open operation require no comment. With the use of this method of treatment, the two bones constituting the joint are maintained in apposition with no possibility of displacement. The apparatus needs little adjustment; the only care required is to have the strap over the injured shoulder, which keeps the clavicle depressed, held firmly by an ordinary buckle.

CASE REPORT

A. C., aged twenty-six years, was struck by an automobile on October 31, 1933. He complained of pain and disability of the left shoulder. The patient was seen on November 7, 1933, one week following injury. Examination revealed a swelling of the shoulder. The acromial end of the clavicle was displaced upward. The roentgenogram (Fig. 1) showed a complete dislocation of the acromial end of the clavicle.

After five cubic centimeters of two per cent. novacain had been injected into the joint, the dislocation was easily reduced. A Böhler clavicular splint was applied (Fig. 2). A roentgenogram taken immediately after application of the splint showed complete

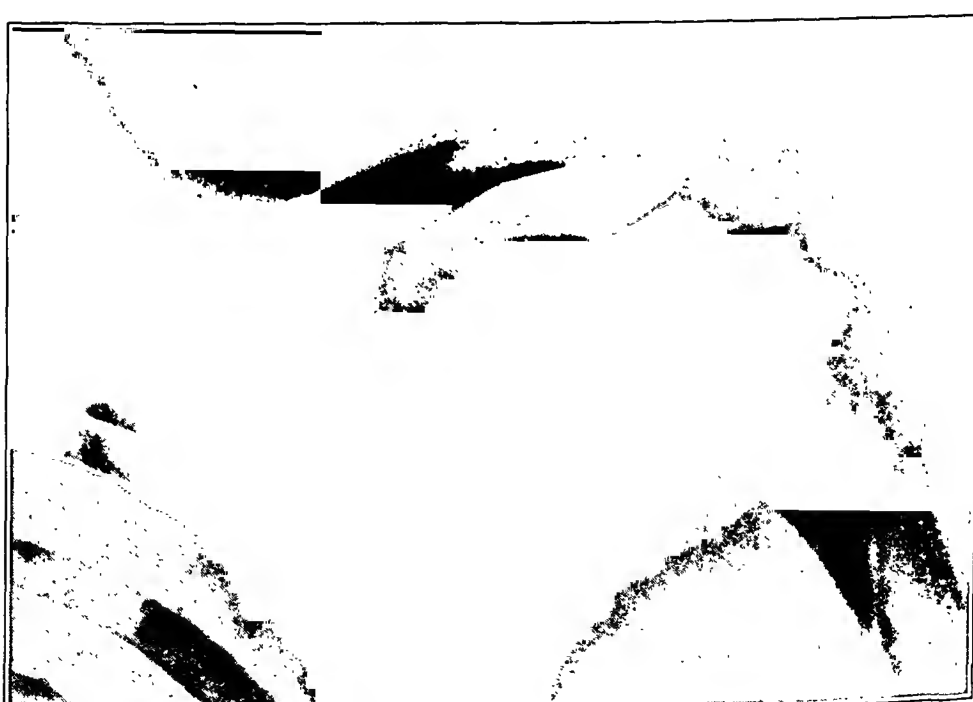

Fig. 3

Roentgenogram after removal of the apparatus, showing complete reduction.

reduction. The apparatus was removed about five weeks later on December 12, 1933. A roentgenogram (Fig. 3) showed that reduction had been maintained. During the time the splint was worn, the patient had complete use of his extremity. At no time was the arm immobilized to his side, permitting stiffness of the shoulder, elbow, or wrist. Consequently, at the time of removal of the apparatus, the patient had a complete range of motion at the elbow and a fair range of motion at the shoulder. Two weeks later the range of motion at the shoulder was complete (Figs. 4 and 5).

FIG. 4

FIG. 5

Seven weeks after reduction, showing complete range of motion.

COMMENT

A method that has been advocated for treatment of incomplete acromioclavicular dislocation has been used successfully for complete dislocation of the acromioclavicular joint. The method is simple with little, if any, discomfort to the patient, and obviates an open operation and a prolonged period of disability.

During the time the splint is worn, the patient has full and free use of his extremity. The shoulder joint, elbow, and fingers are free. He can use the extremity in all light occupations without fear of displacing the clavicle.

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PELLEGRINI-STIEDA DISEASE

Case Report*

BY NATHAN H. RACHLIN, M.D., BROOKLYN, NEW YORK

A complete description of Pellegrini-Stieda disease with a discussion of the literature has been given by Kulowski[1], and repetition is, therefore, unnecessary. Kulowski states that, although a number of cases of this disease (136) have been reported in European literature, no cases have been reported in this country. Since the appearance of this article, however, another case has been reported at the meeting of the American Academy of Orthopaedic Surgeons in January 1934. Doubtless, a good many more cases have come under treatment which have not been reported.

The following case is of especial interest because of the fact that the knee joint was practically ankylosed, and that a good functional result was obtained by operative measures.

CASE REPORT

H. L., male, aged fifty-four years, was admitted to the Orthopaedic Service of the Neurological Hospital, City of New York, on Welfare Island, on October 18, 1933.

He gave a history of having sustained an injury to the upper end of the right tibia in January 1932. He was admitted to the B——— Hospital on January 16, 1932, and was discharged in March 1932, but continued to receive treatment at the same Hospital for two months longer. Since then, motion in the right knee had been limited.

The patient was examined by the writer on October 26, 1933, when the following notes were made: "Joint, on upper and outer aspect, is apparently free. On the inner aspect posteriorly, there is palpable a bony bridge, extending from the upper and inner condylar region of the femur to the tibia. Knee action is about five degrees; patella, slightly movable; thigh muscles, atrophied. Diagnosis: myositis ossificans traumatica. Surgical removal of the osteoma was advised."

The roentgenographic report, made on October 19 by Dr. D. E. Ehrlich, was as follows:

"The bones of the right knee joint reveal an irregular, sclerotic, and osteoporotic process in their adjacent portions. There is some irregularity in structure of the proximal part of the right fibula near the head, which indicates a healed fracture. There is a large calcified area lying adjacent to the medial aspect of the right knee joint, which produces a definite bulge in the soft tissues.

"Spurring of the medial aspect of the tibia at the knee joint is evident. There is also an irregular tranverse healed fracture in the upper end of the tibia, with some roughening at its inner border and cross union to the fibula.

"The pelvis and upper ends of the femora reveal no abnormality except for a slight degree of osteoporosis."

An operation was performed on November 9, 1933. A six-inch longitudinal incision was made on the inner aspect of the tibia, anterior to the tumor mass. The superficial structures were dissected, and the osteoma was found to be imbedded in the tendon of the vastus internus muscle. With an osteotome, the tumor was separated from the

*From the Orthopaedic Service, Neurological Hospital, City of New York, Welfare Island.

FIG. 1
Before operation.

FIG. 2
After operation.

tibia at a point below the capsular attachment, and dissected out upward and backward, without entering the joint at its femoral attachment. The knee joint was then found to be fairly movable.

The deep structures and skin were sutured without drainage, and a knee cast was applied for one week. After active motion had been started, the patient improved rapidly.

The pathological report by Dr. Vera B. Dolgopol was as follows:

"The specimen consists of two flat pieces of bone. One piece is six centimeters long, two and five-tenths centimeters wide, and from four-tenths to one centimeter thick. It is covered by smooth fibrous tissue. At the thicker part, one lateral surface presents the bare cut surface of a hard cancellous bone. The smaller piece, two by one and five-tenths centimeters by five-tenths of a centimeter, shows one cut bony surface, and apparently was chipped off from the larger piece.

"Microscopic sections show a cancellous bone which is fibrous in some places; in other parts it is lamellar. Several pieces of cartilage and an active endochondral bone formation are seen. The osteoblasts predominate over the osteoclasts, except in the proximity of the cartilage. The marrow consists of young connective tissue with large vascular spaces, especially near the cartilage. Fat cells are present in one or two marrow spaces. The tissue on the surface of the bone consists of parallel-strand collagenous fibrous tissue, with some arteries showing endarteritic changes. No muscle fibers are found in the sections."

Physiotherapy was instituted and the patient continued to improve. When examined on December 19, 1933, he had a range of motion in the knee from 180 degrees to 80 degrees. He was discharged on January 19, 1934, and was advised to return in six months for reexamination.

[1] Kulowski, Jacob: Pellegrini-Stieda's Disease. A Report of One Case Surgically Treated. J. Am. Med. Assn., C, 1014, 1933.

TRAUMATIC DISLOCATION OF THE HIP (HEAD OF THE FEMUR) INTO THE SCROTUM

BY ANGUS G. GOETZ, M.D., DETROIT, MICHIGAN

The following case is reported because it seems most unusual. The author has been unable to find a report of a similar case in the literature.

CASE REPORT

P. J., a boy, aged ten years, while riding his scooter on September 11, 1931, was struck by an automobile and hurled about ten feet. He was rushed immediately to St. Joseph's Mercy Hospital. On examination it was found that the left thigh was abducted to beyond a right angle with the pelvis, with extreme internal rotation. There was shortening of the left extremity of about four inches. A mass could be felt within the scrotum, over which the skin was rather tense and discolored; the discoloration and swelling extended over the left inguinal region. The roentgenogram revealed the head of the left femur to be displaced anteriorly and inferiorly to the symphysis, and the greater trochanter to be avulsed slightly above its normal location (Fig. 1).

The patient was placed under gas anaesthesia and, when he was well relaxed, lateral manual traction was applied to the leg. The head of the femur was seen to move out of the scrotum with very little difficulty and to pass over the ramus of the pubis just below the inferior spine of the ilium. Then, by flexion of the thigh and circumduction, the dislocation was easily reduced. There was an immediate massive swelling of the scrotum

FIG. 1

Roentgenogram showing dislocation of the head of the femur into the scrotum and separation of the greater trochanter from the femur, as indicated by the arrow.

FIG. 2

Roentgenogram taken immediately following reduction, showing hemorrhage into the scrotum.

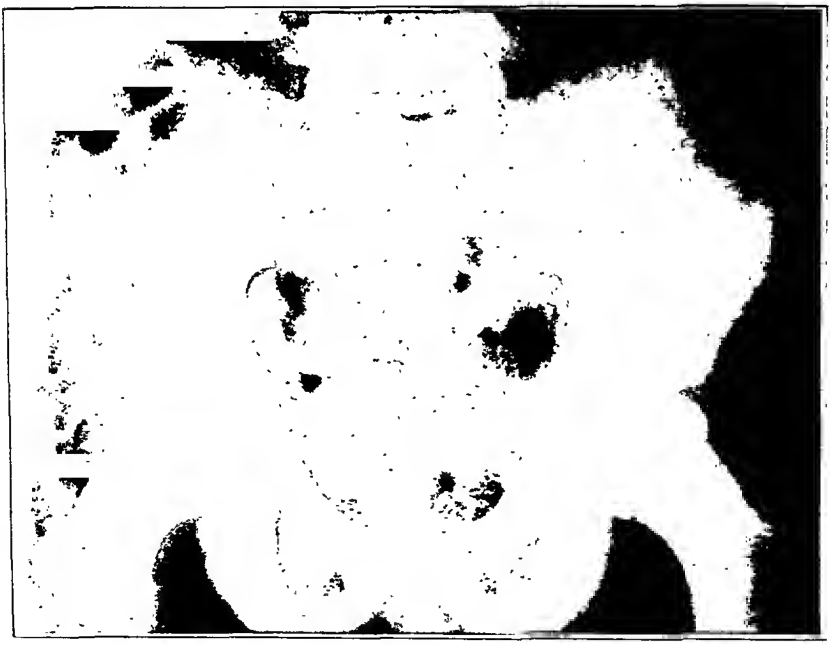

FIG. 3

Roentgenogram taken three and a half months following injury.

to about the size of a small grapefruit; this swelling extended into the left inguinal region. A check-up roentgenogram was taken (Fig. 2).

A support was applied for the scrotum, the legs were bandaged together in extension, and an inlying catheter was introduced. The patient was put to bed and heat was applied. On September 29, 1931, the swelling had greatly subsided, the catheter was removed, and the patient voided voluntarily.

During the first few days of his stay in the Hospital, his temperature rose to 102.4 degrees; the pulse was 148.

Laboratory findings were as follows:

Red blood cells	4,390,000
Hemoglobin	75 per cent.
White blood cells	10,550

The urinalysis was essentially negative.

On the twelfth day, a plaster spica was applied and left on for six weeks. On January 5, 1932, the patient was again examined. He was walking about with a very slight limp; there was a normal range of motion in the hips; the scrotum and testes were normal in size and consistency. The patient had apparently made a normal recovery. Figure 3 shows the roentgenogram taken at this time.

OPERATION FOR BILATERAL OSTEO-ARTHRITIS OF THE HIP*

BY HARRY GOLDBERG, M.D., LOUISVILLE, KENTUCKY

The purpose of this report is to present the record of an unusual case of bilateral osteo-arthritis of the hip, and to point out an operative procedure whereby the stability and painless movement of these hips were obtained.

CASE REPORT

Mrs. M. B., aged forty-three years, was referred on January 25, 1932, complaining of pain and stiffness of both hips, which were more noticeable on the right side.

The family history was negative.

The previous medical history revealed that the patient had walked in a peculiar fashion since she was a child. The discomfort of the hips was first noticed four years ago. The pain and stiffness of the right hip had been gradually increasing during the past two years. During this time the left hip had caused only slight discomfort. The pain had kept her awake at night and she had difficulty in lying in a comfortable position. She had been unable to sit up during the past two years, because of stiffness in the right hip. Changes of weather aggravated the condition. She had been examined for foci of infection, and her teeth had been removed, with no relief of the symptoms.

FIG. 1

Preoperative roentgenogram, showing alteration of the femoral heads with lipping and subluxation.

* Read before the American Academy of Orthopaedic Surgeons, January 10, 1934.

Examination showed the right hip to be fixed in thirty degrees' outward rotation, and motion was restricted in all directions. A few degrees of passive flexion and abduction were possible. The left hip showed an external rotation contracture of thirty degrees. Flexion was limited to ninety degrees, and abduction to ten degrees. Passive extension and adduction were normal. Both knees presented tenderness at the internal lateral ligaments. With the aid of a cane, the patient could walk with an extremely waddling gait. The right lower extremity was dragged with great effort.

The roentgenographic examination showed alteration of the shape of the femoral heads with lipping, coxa valga, subluxation, and slightly flattened and widened sockets (Fig. 1). There was distinct narrowing of the intra-articular spaces. There was present increased density with small cyst-like areas in the head and acetabulum.

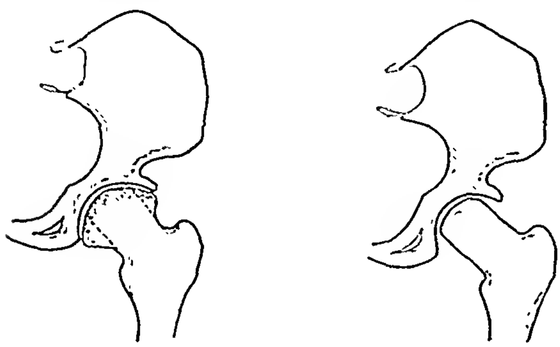

FIG. 2

Diagram of the Jones technique for remodeling the femoral head.

The right hip was operated upon on February 4, 1932. Sir Robert Jones' method of remodeling the head of the femur was the procedure employed. A Smith-Petersen approach was selected, and the incision was made between the tensor fasciae femoris and the sartorius. The rectus femoris was retracted medially, and the gluteal muscles laterally. The capsule of the hip joint was divided and the head of the femur was displaced by rotating the limb outward. The circumference of the femoral head was reduced to that of the femoral neck, leaving the cartilage at the extreme end of the femoral head. This was done with a curved chisel. The raw edges were smoothed with a rasp. The excrescences around the acetabular rim were not

FIG. 3

Postoperative roentgenogram, six months after operation on the right hip, showing the femoral head reduced to the circumference of the femoral neck, and correction of the subluxation.

disturbed. The hip was then reduced by rotating the limb inward, and the wound was closed (Fig. 2).

At this time the left hip was manipulated to increase the range of motion and to correct the outward rotation contracture.

The patient was put in a douhle plaster-of-Paris hip spica with the limbs in moderate ahduction. She remained in the cast for seventeen days, and then was placed in halanced traction to gradually start active motion.

Six weeks after the operation, she was allowed up in a Thomas walking brace, with a cane and a crutch. The patient continued to progress in a satisfactory manner so that she was able to walk comfortahly with only a cane.

Six months later, she commenced to have discomfort in the left hip, which again necessitated the use of a crutch and cane. This state of affairs continued for another six months, when it was decided that a reconstruction operation on the left hip should be done. The right hip continued to give no discomfort.

The left hip was operated on Fehruary 9, 1933. The same procedure and after-treatment were carried out as described for the right hip.

Examination on January 2, 1934, showed:

Right Hip—Flexion to 100 degrees actively, 80 degrees passively; extension normal, no hyperextension; external rotation to 30 degrees, no internal rotation; abduction to 30 degrees actively, 40 degrees passively; adduction normal passively.

Left Hip—Flexion to 110 degrees actively, 90 degrees passively; the other movements were similar to the right hip.

Roentgenographic examination showed the heads of the femora remodeled to the size of the circumference of the femoral necks, the more natural relation of the femoral heads to the sockets, the increased intra-articular spaces, and the apparent disappearance of the small cyst-like areas in the acetabular regions (Figs. 3 and 4 .

Fig. 4

Postoperative roentgenogram, taken January 2, 1934, showing both femoral heads reduced to the circumference of the femoral necks, with correction of the subluxation and apparent disappearance of the small cyst-like area in the acetabular region.

The patient is able to walk comfortably without support and without the marked waddling gait, although she still uses the cane if she walks for a long distance. She is able to sit up for the first time in two years. Her general condition has improved and she sleeps well, as she no longer has pain and can lie comfortably in any position. Her only disadvantage is some difficulty in tying her shoe laces.

DISCUSSION

The operation described minimizes the friction at the joint, which is the exciting cause of the pain and the deformity. The special feature of this operation is the narrowing of the femoral head, which takes care of the subluxation and gives a more mechanically perfect joint. The acetabular excrescences are retained, since their removal may invite a callus formation with possible ankylosis.

AN INSTRUMENT FOR WEDGING PLASTER CASTS

BY FOWLER B. ROBERTS, M.D., M.SC., F.A.C.S., AKRON, OHIO
Orthopaedic Department, Children's Hospital

For many years we used tongue blades and small wood blocks for wedging plaster casts. While fairly satisfactory this method had many faults.

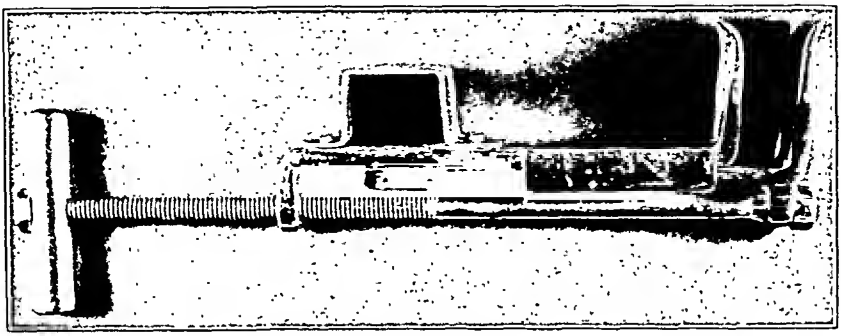

FIG. 1
Spreader assembled.

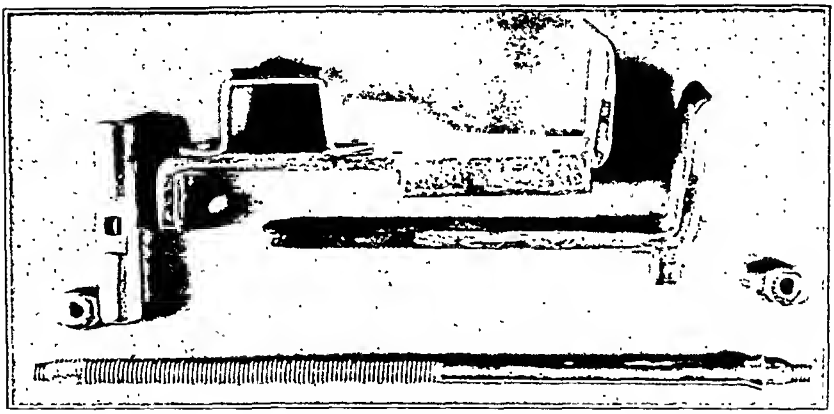

FIG. 2
Individual parts of spreader.

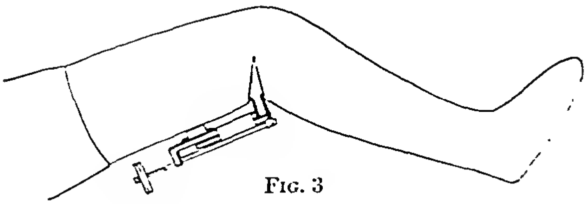

FIG. 3
Showing use of spreader in a leg cast.

To overcome these we had made in our local brace shop the spreader which is shown in the accompanying illustrations. The principle and mechanism can be readily understood from the photographs and drawing. It is convenient to have two or three sizes for casts of various sizes. This instrument has been found very useful and is, therefore, presented in the hope that others may find it of value.

BONE WEDGE "HAMMER" USED IN ARTHRODESIS OF THE SACRO-ILIAC JOINT

BY PIO BLANCO, M.D., BUFFALO, NEW YORK

From the Orthopaedic Service, Buffalo City Hospital.

In performing an arthrodesis of the sacro-iliac joint by the Smith-Petersen technique, a wedge of bone, the full thickness of the ilium, is removed from the location corresponding to the sacro-iliac joint. Thus the sacral surface of the joint is exposed. The cartilage is removed from the wedge of bone and from the sacral surface of the joint. In addition, a layer of the sacrum, about one-quarter of an inch in thickness, is removed with the cartilage. The wedge is then reinserted and driven through into the sacrum.

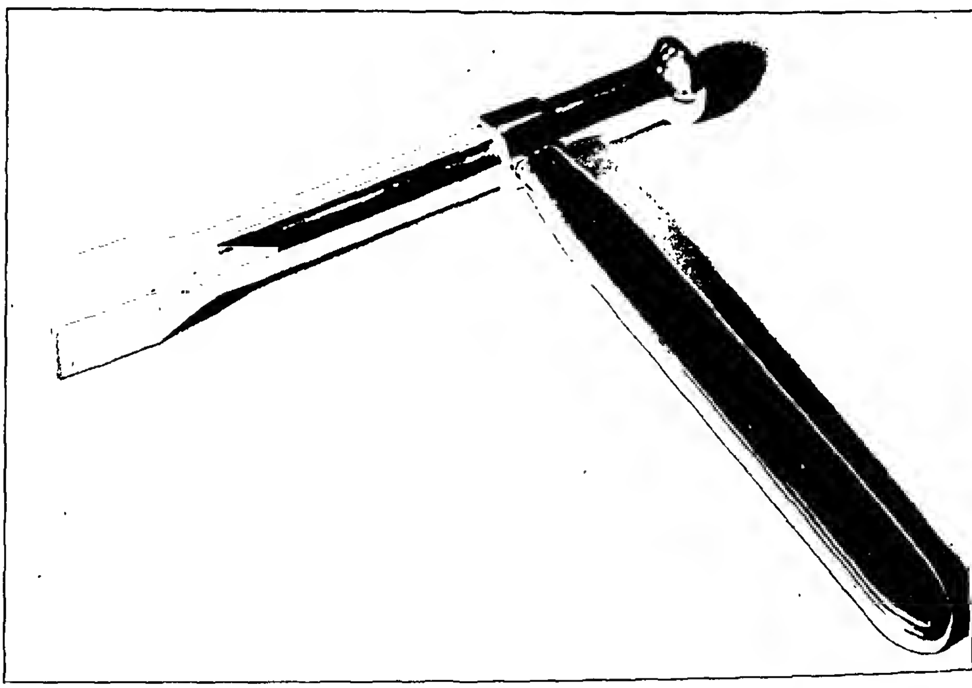

FIG. 1

Due to the great distance from the surface of the ilium to the surface of the skin, especially in obese patients, and since the retraction of the gluteal muscles does not always afford a sufficiently ample exposure, some difficulty may be encountered in driving the wedge of bone. The present instrument has been devised for the purpose of facilitating this stage of the operation.

The instrument shown in Figure 1 consists of a driving shaft, seven inches long. At one end is a flat circular head which receives the mallet. The other end consists of a flat surface, three-quarters of an inch square, which fits over the wedge of bone. The handle is seven and one-half inches long. It is welded at right angles to the driving shaft, two inches distant from its flat head.

A DEMOUNTABLE KIRSCHNER WIRE GUIDE FOR USE WITH THE ALBEE MOTOR

BY BARCLAY W. MOFFAT, M.D., NEW YORK, N. Y.

The majority of men who have used a motor-driven Kirschner wire agree that it has many obvious advantages. Of these, the foremost are the feasibility of using local anaesthesia for the introduction of the wire when it is motor-driven, because of its almost instantaneous passage through the bone; and, secondly, the greater ease in transfixing small fragments—such as those of the olecranon—or bones of curving surfaces,—such as the patella, when it is desired to use traction on a short quadriceps muscle.

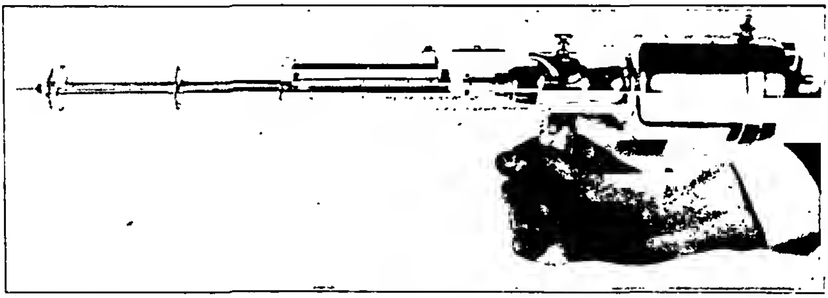

FIG. 1

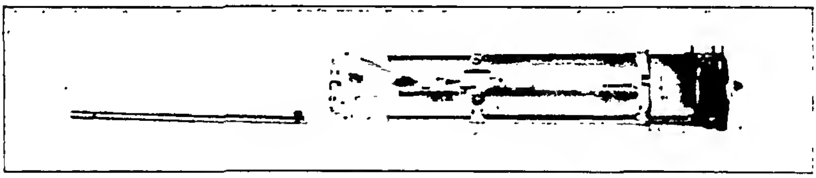

FIG. 2

The apparatus illustrated is designed to make available at low cost a motor-driven wire. Because practically every hospital has an Albee motor, this was used as a basis. The collapsing wire guide is the demountable one manufactured for use in connection with a hand drill. It has been modified so that it may be fastened with two screws to the handle which clamps about the neck of the Albee motor shell. The only other part necessary is a long axle with a set screw. This of course fits in the motor, as does the axle of the saw blades. It will be seen that this use of the Albee motor does not in any way detract from its availability for the purposes for which it was designed.

A SIMPLIFIED APPARATUS FOR THE USE OF RUSSELL TRACTION AND BUCK'S EXTENSION

BY DONALD W. HEDRICK, M.D., DETROIT, MICHIGAN

Division of Orthopaedic Surgery, Henry Ford Hospital

For the past three years it has been the practice in this Clinic to treat certain fractures of the femur in adults, and practically all fractures of the femoral shaft in children and adolescents, with Russell traction. The patient's quick relief from pain, absence of muscle spasm, the ease of control, and satisfactory alignment obtained with this method of immobilization are advantages too well known to warrant discussion.

The success of this method, however, depends entirely upon the correct application of the mechanical principles laid down in 1924 by Russell. Some difficulty was encountered by us at the outset in properly applying the necessary apparatus to the fracture bed, as well as to the ordinary bed.

In this Clinic, fracture beds have the Balkan frames built into them

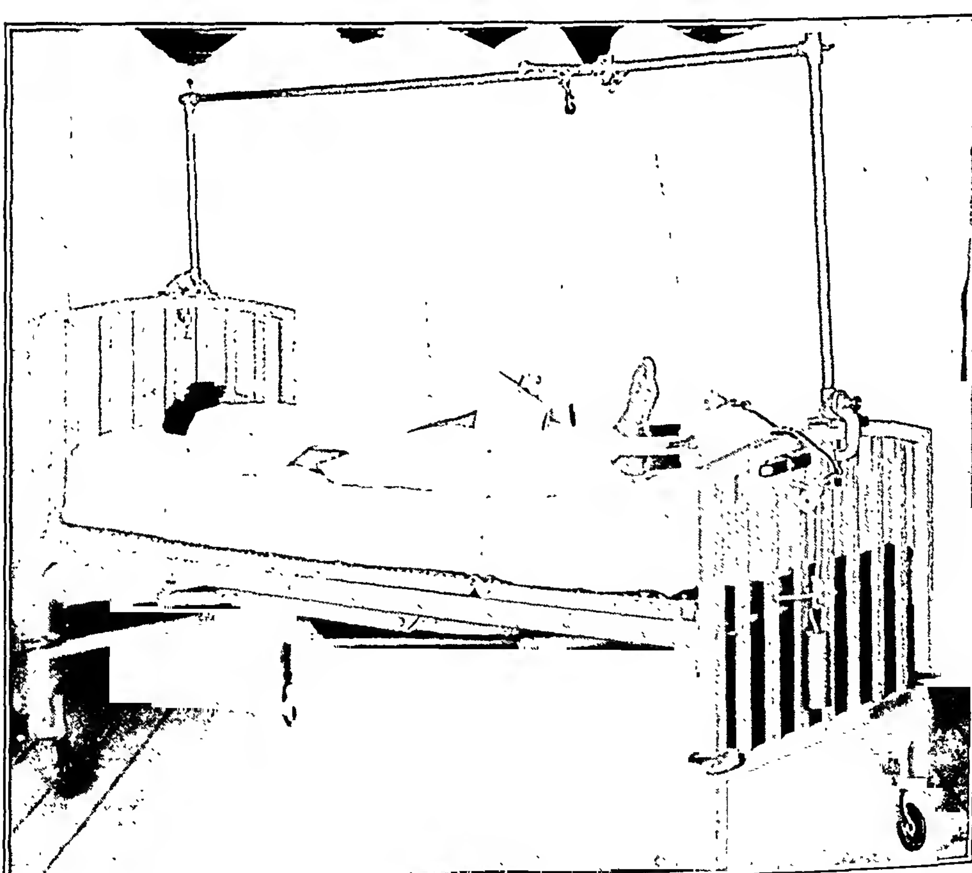

FIG. 1

View of Russell traction with Ann Arbor frame. The appliance described is used at the foot of the bed.

and pulleys at the end are attached to horizontal bars clamped to the frame. The correct angle of the foot pulleys was difficult to adjust and maintain, because the small pulley on the spreader frequently came in contact with the bar pulley, thus decreasing the traction. This was especially true when the patient was an adult of long dimensions. The apparatus described in this paper holds the pulleys far enough over the bed to eliminate much of this interference.

Most occasions for the use of Russell traction, however, arise with the treatment of fractures in children, for whom we have no fracture beds with incorporated Balkan frames. In these cases we use the so called Ann Arbor frame, which is a midline horizontal bar elevated by two vertical bars which are

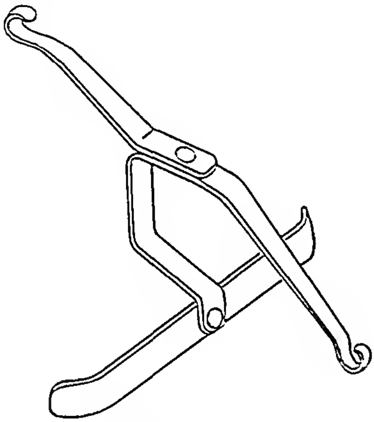

FIG. 2
Detail of the appliance.

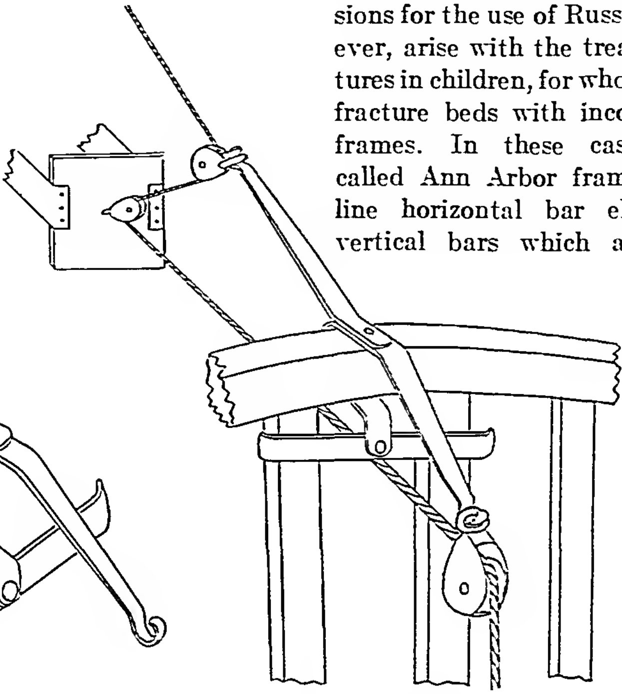

FIG. 3
Detailed sketch of apparatus attached to bed frame.

clamped to the end of the bed (Fig. 1). Pulleys are attached to the main bar or to small bars clamped at right angles to the uprights on the main bar. Short bars, clamped in this manner to round bars, slip if much tension by traction is applied; this slipping immediately changes the direction and amount of the traction. Here again the appliance described eliminates the difficulty and maintains a positive, fixed traction, the most important factor in the treatment of fractures of the long bones where displacement of the fragments exists.

The apparatus, as illustrated (Fig. 2), is made of heavy strap iron and measures eleven inches between the pulley rests. The cross piece is eight inches long. The portion which encircles the upper part of the bed frame must be large enough to slip on the end of a standard hospital bed. The lower or distal pulley holds the apparatus securely in place as soon as the traction rope is threaded through. The downward pull of the

suspended weight forces the cross piece firmly against the uprights at the end of the bed. Once in place, its position is maintained until the traction is released, so that it cannot be disturbed by the patient or others in the room (Fig. 3). The upper or proximal pulley is used as the second in the series necessary in Russell traction to produce the component of the vertical and longitudinal traction in the line of the femur.

In addition to its use in Russell traction, this appliance can be used for Buck's extension by utilizing only the lower pulley for a direct pull on the lower extremity.

The use of this apparatus greatly simplifies immobilization in the home as well as in the hospital. It is easily and quickly applied to all hospital beds and the majority of other beds. The pulleys cannot become twisted or the rope tangled. The traction cannot be disturbed.

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2. Russell, R. H.: Fracture of the Femur: A Clinical Study. British J. Surg., XI, 491, 1924.

JAMES THOMAS WATKINS

Dr. James Thomas Watkins died at his home in San Francisco on February 18, 1934, at the age of sixty-three.

Dr. Watkins was born in Baltimore, Maryland, but his youth was passed in California. He received his academic education at the University of Virginia, his medical degree from Columbia University in 1894, and spent three years in the St. Francis and New York City Hospitals. Following this, he studied orthopaedic surgery in various European centers for three years, working with Hoffa, Lange, and Lorenz. Returning home, he located in San Francisco in 1902 and at once began the practice of orthopaedic surgery. He became associated with Dr. Harry M. Sherman and received appointments on the staff of the Children's Hospital and on the teaching force of the University of California Medical School, which institutions he continued to serve until his death. His long study of European orthopaedic methods, coupled with Dr. Sherman's practical ex-

perience, made an association of great benefit to both men and lasted until the death of Dr. Sherman in 1925.

In 1903, Dr. Watkins married Eleanor Fairman Preston, of Virginia, herself a recent medical graduate; and she, with four sons, survives him.

Dr. Watkins was always interested in public service and devoted much of his time to it. After the great San Francisco earthquake and fire in 1906, he was City Health Officer from 1907 to 1910, and did much to reorganize the Health Department and to start it on the path of development to its present high state of efficiency.

During the War, in 1917 and 1918, he served as contract surgeon in the Letterman Hospital in San Francisco, but his health at that time prevented his taking more active service.

Besides being a charter member of the American College of Surgeons and elected to the American Orthopaedic Association in 1907, he helped to organize the San Francisco Orthopaedic Club and was its President in 1925, 1926, and 1927. In 1927 he also served as President of the American Orthopaedic Association at its Yosemite Valley meeting, and it was due largely to his untiring efforts that this meeting was so much enjoyed by the members. In 1933, he was elected as the first President of the Western Orthopaedic Association.

His memberships in other societies, contributions to orthopaedic literature, and consulting appointments to hospitals were numerous, and indicated his love for his specialty and his ability for hard work, in which he continued until his death.

His personal character commanded the confidence and veneration of his patients and the respect of his colleagues. He had a certain directness or bluntness of thought that was impatient with, and brushed aside, all pretense or sham in his professional work and sometimes made him enemies, but this quality was tempered by a good sense of humor and facility of expression which made his discussion of medical papers and other public utterances always free from monotony as well as scientifically worth while.

In short, the orthopaedic surgeons of the Pacific Coast feel that they have lost their leader, not only in the length of service, but in general orthopaedic knowledge and devotion to professional ideals.

News Notes

The Twenty-Ninth Congress of the Deutsche Orthopädische Gesellschaft will be held in Dortmund, October 8, 9, and 10, under the presidency of Prof. Dr. M. Brandes. The first day will be devoted to the results of research on subjects of scientific interest, the second day to the presentation of clinical material, and the third day to technique and practical demonstrations. During the Congress especial emphasis will be placed on the consideration of the condition of and the parts played by the muscles, particularly with reference to their function; epiphysitis, the different forms of osteochondritis, and allied conditions; club-foot, its forms and its treatment in different ages from the new-born to adults and relapsed cases; and the general methods of body development and training. In addition to these subjects, a large number of papers on interesting subjects will be presented by different members of the Congress.

From the Istituto Ortopedico Rizzoli in Bologna, Italy, has been received the notice of the competition for the Prize Umberto I. This prize of 3,500 lire will be assigned, according to the decision of the Provincial Council of Bologna, for "the best orthopaedic work or invention." Italian and foreign doctors may take part in this competition which will close on December 31, 1934. Application for the competition should be made to the President of the Rizzoli Institute in Bologna, who will supply the rules of the competition.

The Fourth International Congress of Radiology is to be held in Zurich and St. Moritz, Switzerland, on July 24 to 31, under the patronage of Dr. M. Pilet-Golaz, the President of the Swiss Confederation. The President of the Congress is Prof. Dr. H. R. Schinz. On July 24 through 28, the meetings will be held at the University and the Institute of Technology in Zurich, and on July 29 through 31 at St. Moritz. A large number of papers will be read by men from various countries, and a very interesting program has been arranged. All inquiries for information in regard to the meeting should be addressed to the General Secretary, Dr. Hans E. Walther, Gloriastrasse 14, Zurich.

The International Society of Radio-Biology has announced the First International Congress of Electro-Radio-Biology. This Congress will meet from September 10 to 15 in the Doges Palace at Venice, Italy, and will be presided over by His Excellency the Marquis Guglielmo Marconi, President of the Royal Academy of Italy and of the National Council of Research, and State Senator, and by His Excellency, Count Giuseppe Volpi di Misurata, State Minister and State Senator.

The object of this Congress is to invite physicists, chemists, biologists, naturalists, and physicians to discuss the biological actions of all radiations in order to coordinate the respective investigations.

For further information about the Congress, address the General Secretary, Dr. Giocondo Protti, S. Gregorio 173, Venice, Italy.

The thirteenth annual scientific and clinical session of the American Congress of Physical Therapy will be held in Philadelphia at the Bellevue Stratford, September 10, 11, 12, and 13.

On Wednesday evening, September 12, a joint session will be held with the Philadelphia County Medical Society and on Friday, September 14, the question of hospital teaching will be considered and clinics will be held in the leading institutions of Philadelphia.

Special features will be the scientific and technical exhibits and the small group conferences. Outstanding clinicians and teachers will present the results of the newer researches in the field, emphasizing short-wave therapy, hyperpyrexia, light therapy, remedial exercise, massage, and other interesting subjects.

For preliminary program, address American Congress of Physical Therapy, 30 North Michigan Avenue, Chicago, Illinois.

The semi-annual meeting of the **Minnesota Orthopaedic Club** was held in Minneapolis and St. Paul on Saturday, March 31, 1934.

An operative clinic was given in the morning by Dr. Wallace H. Cole, at the Shriners' Hospital, who demonstrated the operative procedure for leg lengthening. In the afternoon cases were presented by other members of the Staff. Following the dinner, Dr. C. C. Chatterton presented a group of cases of aseptic necrosis of the head of the femur, appearing a year after severe trauma, and the importance of this complication from a standpoint of industrial compensation was stressed. Dr. Cole also presented other interesting cases, particularly tibial defects following resection for osteomyelitis, and showed the results of different operative procedures.

At the business session it was decided to enlarge the Club by adding to the membership orthopaedic surgeons from North Dakota and South Dakota, and in the future the Club will be known as the Minnesota-Dakota Orthopaedic Club. Dr. Vernon Hart, of Minneapolis, Dr. H. J. Fortin and Dr. Joel C. Swanson, of Fargo, North Dakota, and Dr. G. E. Van Demark, of Sioux Falls, South Dakota, were elected to membership.

The Fourth Congress of the Polish Orthopaedic Association was held in Lwow, Poland, on November 6 and 7, 1933, under the Presidency of Prof. Wojciechowski, with an attendance of about one hundred members, representatives of the Government, and guests. Prof. Zahradniček was the official delegate of the Czechoslovakian Orthopaedic Association, of which he is president.

In the scientific meetings the two principal subjects considered were: (1) The care of the Cripple in Poland, and (2) The Mobilization of Ankylosed Joints. On the first subject, Dr. Kosinski and Dr. Cetkowski considered the question of better organization for the care of the crippled in Poland, and the discussion distinctly brought out the need for a committee on the care of cripples, and the necessity of closer contact of the Orthopaedic Association with the Government.

Prof. Gruca delivered an exhaustive report of the work in the field of arthroplasty, including the method of selection and examination of cases for operation, as well as the technique and end results. This operation was discussed by various members and guests of the Association. Short papers were also presented by other members and guests.

In executive session the following were elected as Honorary Members of the Polish Orthopaedic Association:

Prof. Vittorio Putti, Bologna, Italy.
Prof. G. Nové-Josserand, Lyon, France.
Prof. Etienne Sorrel, Paris, France.
Prof. H. L. Rocher, Bordeaux, France.
Prof. A. Maffei, Brussels, Belgium.
Prof. Maksymiljan Rutkowski, Cracow, Poland.
Prof. Hilary Schramm, Lwow, Poland.

The next Congress will be held in 1934 in Poznan, under the Presidency of Prof. Wojciechowski.

The Fifth Congress of the Pan-American Medical Association was held from March 14 to March 30, 1934, on board the Panama Pacific liner "Pennsylvania" during a cruise to the West Indies and South America. There was a large attendance, and those who participated in this Congress indicated that the group was especially interested in the expressed purpose and objective of the Pan-American Medical Association,—namely, to cultivate a better understanding between the men who are devoting their lives to the practice of medicine and surgery and the advancement of scientific knowledge throughout the twenty-two republics of this western hemisphere.

Meetings were held in the morning and part of the afternoon and evening for seven days of the cruise. The orthopaedic group met with the Sections of Roentgenology and Dermatology, which plan proved to be particularly successful. During the afternoons a general assembly was held in which papers were given on various subjects. The following papers were presented by members of the orthopaedic section:

Dr. Fred H. Albee, Presidential Address—"The Operative Treatment of Spinal Curvatures". He advocated use of the full-thickness tibial graft in its application to the spine.

Dr. Edward A. Cayo—"An Orthopaedic Surgical Engine". The engine is original, efficient, and practical. It consists of a cross-cut saw which will saw anything from a straight line to a circle a quarter of an inch in diameter, and will not puncture the soft tissues; there are also a chisel, a drill, trephine, and circular saws.

Dr. Edward L. Compere—"Tuberculosis of the Spine in Children". He called attention to the fact that the principle of fusion of the spine is almost universally accepted in this hemisphere as far as adults are concerned, but there are still many surgeons who believe that the results do not justify this procedure in children. He gave the results of treatment by spine fusion in a group of children eight years of age or younger.

Dr. Ralph K. Ghormley—"Fractures of the Humerus". Dr. Ghormley presented a review of 350 cases.

Dr. G. DeN. Hough, Jr.—"The Correction of Hip Flexion Deformity in Anterior Poliomyelitis". He presented an analysis of 168 hip flexion deformities in 130 children, with a review of the different methods of correction.

Dr. Alberto Inclan—"Extra-Articular Fusion in Hip Diseases". He reported that failure in some instances is due to a pseudarthrosis at the site of attachment of the graft in the region of the greater trochanter. He believes that the combined intra-articular and extra-articular methods of fixation are most successful.

Dr. C. L. Lowman—"Surgical Stabilization of the Paralytic Pelvis". He called attention to the three major deviations of the body segments, due to paralysis of the abdominal muscles,—namely (1) increased obliquity of the pelvis, flexing it forward on the hip joints; (2) lateral tilting from weakness of side muscles; (3) twisting of the vertebral column and formation of scoliotic deformity.

Dr. Jose Londres—"Osteogenic Exostoses". He presented a very interesting case of congenital exostoses with several hundred osteocartilaginous overgrowths.

Dr. W. R. MacAusland—"Arthroplasty of the Knee Joint". He called particular attention to the features which stood out prominently in his experience in making selection of cases for operation. He said that the indications for arthroplasty which must be considered carefully before operation include the origin and duration of the ankylosis, the age of the patient, the condition of the skin, musculature, and bone, and, finally, the general health of the patient: he considers the last factor very important. He always uses an operative technique which assures the maintenance of stability, for stability must not be sacrificed in order to obtain complete motion.

Dr. William Nachlas—"Pseudo Angina Pectoris Originating in the Cervical Spine". He stated that angina pectoris is a diagnosis based on symptoms, and that there is a pathological condition of the cervical spine which produces the same symptoms.

Dr. Alfred A. Richman—"The Conn Fixation Method for Open Reduction of Fractures with Modifications".

Dr. Earl D. McBride—"Permanent Disability from Deformity in Fractured Bone Shafts".

Dr. J. W. Sever—"Obstetrical Paralysis".

Dr. Ortiz Tirado—"The Use of the Bone Graft in Surgery in Mexico".

Papers read by members of the Orthopaedic Section before the general assembly at the afternoon sessions included:

Dr. Ralph K. Ghormley—"Low Back Pain".

Dr. Fred Albee—"Treatment of Advanced Tubercular Joint Disease".

Dr. Edward L. Compere—"Metabolism of Calcium and Phosphorus in Health and Disease".

The Forty-Eighth Annual Meeting of the American Orthopaedic Association was held at The Mayo Clinic, Rochester, Minnesota, June 6 to 9, under the presidency of Dr. Melvin S. Henderson. Dr. Murk Jansen, of Leiden, Holland, and Mr. W. Rowley Bristow, of London, England, were present as guests of the Association.

The morning of the first day was devoted to the presentation of cases and clinical demonstrations at St. Mary's Hospital.

The sessions on June 7 and 8 and the morning of June 9 were held in Plummer Hall and papers of special scientific interest were presented by the members and guests.

The program as arranged by the Committee was as follows:

THURSDAY, JUNE 7

Morning Session

Symposium on the Open Treatment of Congenital Dislocation of the Hip:
- Selection of Cases for Operation.
  - Dr. A. H. Freiberg, Cincinnati, Ohio.
- Operative Technique:
  - Treatment Based on Physiology of Congenital Dislocation of the Hip.
    - Dr. Steele F. Stewart, Los Angeles, California.
  - The Operative Technique with Some of Its Complications.
    - Dr. Wallace H. Cole, St. Paul, Minnesota.
- Late and End Results.
  - Dr. F. C. Kidner, Detroit, Michigan.
  - Dr. B. P. Farrell, New York, N. Y.

Afternoon Session

Symposium on the Open Treatment of Congenital Dislocation of the Hip (Continued):
- Plastic Operations:
  - Dr. Frank D. Dickson, Kansas City, Missouri.
  - Dr. A. Bruce Gill, Philadelphia, Pennsylvania.
    - A Shelving Operation by Means of Peg Graft from Tibia.
      - Dr. D. B. Phemister, Chicago, Illinois.
      - Dr. E. L. Compere, Chicago, Illinois (by invitation).
    - Some Observations on Results of Shelf Operations in Congenital Dislocation of the Hip, Covering a period of Thirteen Years. Report of Twenty-Four Cases.
      - Dr. F. R. Ober, Boston, Massachusetts.
- Neck or Shaft Plastic:
  - Schanz Osteotomy in Irreducible Congenital Dislocation of the Hip.
    - Dr. F. J. Gaenslen, Milwaukee, Wisconsin.

FRIDAY, JUNE 8

Morning Session

Treatment of Fractures of the Os Calcis.
Dr. H. R. Conn, Akron, Ohio.
President's Address: Leadership in Orthopaedic Surgery.
Dr. M. S. Henderson, Rochester, Minnesota.
Traumatic Dislocation of the Tendon of the Long Head of the Biceps Brachii.
Dr. LeRoy C. Abbott, San Francisco, California.
Internal Derangements of the Knee.
Mr. W. Rowley Bristow, London, England.
The Treatment of Acute Purulent Arthritis by Joint Washing.
Dr. Hugh Jones, Los Angeles, California.
Treatment and End Results of Adolescent Epiphyseolysis of the Upper End of the Femur.
Dr. P. D. Wilson, New York, N. Y.
Pinching of the Ligamentum Teres of the Hip.
Dr. Murk Jansen, Leiden, Holland.

Afternoon Session

The Treatment of Legg-Calvé-Perthes Disease without Weight-Bearing.
Dr. Murray S. Danforth, Providence, Rhode Island.
Tendon Fixation in Infantile Paralysis—Late Results.
Dr. W. E. Gallie, Toronto, Canada.
Traumatic Separation of the Medial Epicondyle of the Humerus in Adolescence.
Dr. John Dunlop, Pasadena, California.
Endothelial Myeloma; Analysis of Cases.
Dr. Willis C. Campbell, Memphis, Tennessee.
X-Ray Studies of the Diaphragm in Children. Its Correlation with Body Mechanics.
Dr. Lloyd T. Brown, Boston, Massachusetts.

SATURDAY, JUNE 9

Morning Session

Papers by members of the Staff of The Mayo Clinic:

Lymphoedema.
Dr. E. V. Allen
Roentgen Visualization of the Vessels of the Extremities.
Dr. N. W. Barker
Medical and Orthopaedic Aspects of Arteriovenous Fistulae.
Dr. B. T. Horton
Abnormalities of the Osseous System Associated with Anaemia and Splenomegaly.
Dr. H. Z. Giffin
Dr. J. D. Camp
Dental Diagnosis—Its Relation to Mineral Metabolism.
Dr. B. S. Gardner
Dicalcium Phosphates in Bone Metabolism—An Experimental Study.
Dr. G. M. Higgins
The Curability of Malignant Tumors of the Upper Jaw and Antrum.
Dr. G. B. New
Intraspinal Tumors with Orthopaedic Manifestations.
Dr. H. L. Parker
Studies of Cataphoresis of Streptococci.
Dr. E. C. Rosenow

The Annual Dinner was held on Friday evening, June 8, at the Hotel Kahler.

At the Executive Session held on June 9 the following nine orthopaedic surgeons were elected to membership:

Edward L. Compere, M.D., Chicago, Illinois.
Richard B. Dillehunt, M.D., Portland, Oregon.
John G. Kuhns, M.D., Boston, Massachusetts.
Toufick Nicola, M.D., New York, N. Y.
William A. Rogers, M.D., Boston, Massachusetts.
George W. VanGorder, M.D., Boston, Massachusetts.
George W. Wagoner, M.D., Philadelphia, Pennsylvania.
J. Warren White, M.D., Greenville, South Carolina.
Isadore Zadek, M.D., New York, N. Y.

And the following were elected Corresponding Members of the Association:

Mr. W. Rowley Bristow, London, England.
Mr. W. A. Cochrane, Edinburgh, Scotland.
Mr. Naughton Dunn, Birmingham, England.
Dr. Bedřich Frejka, Brno, Czechoslovakia.
Dr. Charles Lasserre, Bordeaux, France.
Mr. T. P. McMurray, Liverpool, England.
Dr. M. zur Verth, Hamburg, Germany.

The following officers were elected for the ensuing year:

President: DeForest P. Willard, M.D., Philadelphia, Pennsylvania.
President-Elect: Frederick J. Gaenslen, M.D., Milwaukee, Wisconsin.
Vice-President: Benjamin P. Farrell, M.D., New York, N. Y.
Treasurer: John L. Porter, M.D., Evanston, Illinois.
Secretary: Ralph K. Ghormley, M.D., Rochester, Minnesota.
Editor: E. G. Brackett, M.D., Boston, Massachusetts.
Member of Executive Committee: Melvin S. Henderson, M.D., Rochester, Minnesota.
Member of Membership Committee: John C. Wilson, M.D., Los Angeles, California.
Member of Program Committee: Rexford L. Diveley, M.D., Kansas City, Missouri.

Delegates to the American College of Surgeons: D. B. Phemister, M.D., Chicago, Illinois; David Silver, M.D., Pittsburgh, Pennsylvania; William B. Owen, M.D., Louisville, Kentucky.

Delegates to the American Board of Orthopaedic Surgeons: Philip D. Wilson, M.D., New York, N. Y.; W. B. Carrell, M.D., Dallas, Texas. Alternate: Oscar Lee Miller, M.D., Charlotte, North Carolina.

Delegate to the Congress of Physicians and Surgeons: J. Torrance Rugh, M.D., Philadelphia, Pennsylvania. Alternate: Robert D. Schrock, M.D., Omaha, Nebraska.

The next meeting of the Association will be held in Philadelphia, Pennsylvania, under the presidency of Dr. DeForest P. Willard.

UNDERGRADUATE INSTRUCTION IN ORTHOPAEDIC SURGERY

Report of Committee Appointed by the American Orthopaedic Association*

A committee of five teachers of professorial rank was appointed by the President of the American Orthopaedic Association, after its Annual Meeting in 1932, and was instructed to review the present undergraduate instruction in Orthopaedic Surgery in the medical schools throughout the United States and Canada and to make suggestions as to the desirable scope and nature of such instruction. This Committee has submitted its report.

By means of a questionnaire sent to the heads of Departments of Orthopaedic Surgery in the Class A medical schools of the United States and Canada, the following epitomized statistical information was obtained from 91.5 per cent. of the replies.

A. Hours of instruction:

1. The number of whole class (chiefly didactic) hours of instruction at present being devoted to Orthopaedic Surgery in the different medical schools during the four undergraduate years is found to vary from eight to ninety.
2. The number of clinical (section work) hours is found to vary from twelve to 150.

B. Subjects in which instruction is being given by Departments of Orthopaedic Surgery are listed in order of frequency:

1. Tuberculosis of the bones and joints
2. Congenital defects and lesions
3. Anterior poliomyelitis
4. Scoliosis
5. Faulty statics, chiefly foot strain
6. Rickets and allied diseases (scurvy, osteomalacia, chondrodystrophies, osteogenesis imperfecta, etc.)
7. Spastic palsy, obstetrical paralysis, Volkmann's contracture, etc.
8. Nutritional growth disturbances, osteochondritis, epiphysitis, etc.
9. Fractures and dislocations (in whole or in part)
10. Osteomyelitis (in whole or in part)
11. Mechanical derangement of joints (chiefly knee)
12. Acute and subacute infectious arthritis
13. Chronic arthritis (in whole or in part)
14. Traumatic joint lesions (chiefly industrial)
15. Body mechanics and posture
16. Methods of examination of joints and of diagnosis
17. Neoplasms of bone (in whole or in part)
18. Operative technique
19. Traumatic arthritis
20. Reaction of joints to various irritations
21. Lesions and affections of bursae
22. Physical therapy
23. Orthopaedic pathology
24. Ankylosis
25. Normal and surgical joint anatomy
26. Back pain

*Presented at the Annual Meeting of the American Orthopaedic Association at Rochester, Minnesota, June 7, 1934, by Robert B. Osgood, M.D., Chairman.

27. Luetic disease of bones and joints
28. The history of orthopaedic surgery
29. Apparatus, plaster-of-Paris technique, etc.
30. Diseases of the vascular system
31. Diseases of the neuromuscular system
32. Prevention of deformity
33. Correction of deformity
34. Myositis
35. Scar contractures
36. The relation of orthopaedic surgery to industry
37. Laboratory findings
38. Lesions of tendons
39. The physiology of the bones and joints
40. Orthopaedic complications
41. The principles of orthopaedic surgery and the etiology of deformities.

In about seventy per cent. of the replies, it was stated that, in the instruction given, greater emphasis is being placed upon the detail of examination and diagnosis than upon treatment.

About twenty-six per cent. replied that examination and diagnosis and treatment received about equal emphasis in the instruction given. Two did not answer the question, but in no reply was it stated that more emphasis was placed upon treatment than upon detail of examination and diagnosis. This finding the Committee feels represents a fortunate situation.

Coordinated or overlapping instruction is being given by other departments than the Department of Orthopaedic Surgery in over fifty per cent. of the medical schools. The following subjects are listed in order of the frequency in which such instruction is being given:

1. Fractures and dislocations
2. Chronic arthritis
3. Osteomyelitis
4. Anterior poliomyelitis, neurology or neurosurgery
5. Neoplasms of bone
6. Rickets and allied conditions
7. Vascular diseases
8. Tuberculosis of the bones and joints
9. Birth injuries
10. Bone and joint pathology
11. Physical therapy
12. Septic joints.

A certain amount of overlapping instruction is probably inevitable and may be occasionally advisable. Some of the replies suggest that the overlap is so broad as to at least waste the student's time if it does not actually confuse him.

COMMENT

It is evident that the scope of Orthopaedic Surgery has broadened along with the scope of instruction in General Surgery and Medicine and in some of the other special branches. Those in charge of the curricula of medical schools are placing important responsibilities on Departments of Orthopaedic Surgery.

An analysis of the replies reveals the fact that at present nearly all Departments of Orthopaedic Surgery are responsible for the major instruction in:

1. Congenital defects, lesions, and diseases of the bones, joints, and muscles
2. Tuberculosis of the bones and joints

3. Anterior poliomyelitis (after the acute stage)
4. Scoliosis
5. Faulty statics and faulty weight-bearing
6. The deformities of rickets and certain of the growth disturbances of the skeleton
7. The locomotor difficulties of cerebral palsy, obstetrical paralysis, Volkmann's contracture, etc.

It is interesting also to find that more than fifty per cent. of the Departments of Orthopaedic Surgery are responsible for instruction (either in whole or in part) in the following subjects:

Traumatic joint lesions	(72 per cent.)
Fractures and dislocations	(68 per cent.)
Osteomyelitis	(68 per cent.)
Mechanical derangements of joints	(61 per cent.)
Infectious arthritis (acute or subacute)	(52 per cent.)
Chronic arthritis	(52 per cent.)

It was suggested in the original motion, which resulted in the appointment of this Committee instructed to survey and report upon the status of undergraduate instruction in Orthopaedic Surgery, that an attempt be made to outline an ideal course of undergraduate instruction in Orthopaedic Surgery.

The Committee feels that the differences in organization of Departments of Orthopaedic Surgery and in the interests and training of the local general surgical and orthopaedic personnel in the various medical schools make it undesirable, and indeed futile, for the Committee to attempt to standardize or even to outline in any rigid way such an ideal course. The Committee has deemed it more profitable to call attention to the findings of the questionnaire which indicate the present situation, and to list the subjects and conditions in which, in its opinion, undergraduate instruction might well be given in whole or in part by a Department of Orthopaedic Surgery. The subjects and conditions have been listed in a rough order of sequence and importance of instruction:

1. Functional and surgical anatomy of the bony skeleton and locomotor system and normal body mechanics. (In cooperation and coordination with the Department of Anatomy and perhaps the Department of Physiology.)
2. Methods of examination of bones, joints, bursae, muscles, and closely associated structures and systems. This instruction should constitute an integral part of the course in Physical Diagnosis now generally supervised by the Departments of General Medicine and Roentgenology.
3. The diagnosis, pathology, and etiology, together with the prevention, "first-aid" treatment, and the general principles of treatment of defects, lesions, and diseases of the bones, joints, bursae, muscles, tendons, and of their vascular, nervous, and sometimes visceral mechanisms. (In cooperation and coordination with the Departments of Surgery, Medicine, Pediatrics, Neurology, Pathology, and possibly Bacteriology.)
4. The scope and general principles of Orthopaedic Surgery and its relation to industry and workmen's compensation.
5. The scope and general principles of physical therapy and the application of the simpler methods of its administration.

C. Number of hours of Orthopaedic instruction during the four-year course:

1. Whole class exercises.

The Committee is of the opinion that a certain number of whole-class exercises may be advantageously employed in an explanatory manner during the four years, in order to indicate the scope and general principles of the specialty. From a review of the findings of the questionnaire, the Committee came to the conclusion that in several of the leading medical schools

approximately twenty-four such exercises of an hour's duration were being profitably employed in this manner during the four years, the majority of the hours being assigned to the third year. In about sixty-eight per cent. of the medical schools, Departments of Orthopaedic Surgery are being held responsible for a part of or for the entire instruction in fractures and dislocations. Where the entire instruction in these subjects is to be given by a Department of Orthopaedic Surgery, the Committee suggests that twelve more whole-class exercises should be provided to cover the subjects of Fractures and Dislocations.

2. Clinical instruction in sections.

The Committee is of the opinion that clinical instruction to small sections, preferably of not more than twelve students, should be given (1) by the Department of Orthopaedic Surgery in the wards and out-patient departments of the teaching hospitals and (2) by conferences and ward rounds in conjunction with the surgical and medical staffs. Where the material is ample and the staff of teachers is sufficiently large, the Committee suggests that each student should receive during his four years not less than seventy, and not more than one hundred, hours of such instruction. If this clinical instruction is to include the subject of Fractures and Dislocations, and the Department of Orthopaedic Surgery is held responsible for the entire undergraduate instruction, perhaps thirty-five to fifty more hours of instruction per student should be added.

D. Organization of Departments of Orthopaedic Surgery:

In many of the leading medical schools, Departments of Orthopaedic Surgery are evidently accepting in an entirely satisfactory manner the large responsibilities which have been placed upon them by curricula committees. In other schools these ideals of usefulness are not being completely realized, perhaps because the Departments have lacked any opportunity to attempt such realization and perhaps because the Departments have lacked the ability to take advantage of the opportunity when it has been offered.

The Committee holds no fixed opinion as to whether a Department of Orthopaedic Surgery is likely to function best as an entirely independent department or as one of the sections of the Department of Surgery. Excellent undergraduate instruction in Orthopaedic Surgery is at present being given by departments which function under each one of these plans of organization, and both plans have their advantages and disadvantages.

The replies to the questionnaire indicate that over eighty per cent. of the Departments of Orthopaedic Surgery are functioning as actually or practically independent departments. The Committee feels that Orthopaedic Surgery merits as favorable a consideration in this respect as any other of the special branches of surgery.

The organization of some medical schools provides for a single head for all the major departments. If such an organization obtains, it is obviously advisable that a "chief" should keep in closest touch with all the special departments under him and be freely accessible to those in charge of these departments. It is still more important that in schools where autonomous special departments exist, there should be close coordination of teaching between the major departments of medicine, surgery, and pediatrics and the special departments. This is peculiarly true in relation to Orthopaedic Surgery since, in general, this branch of surgery may be said to deal more with the principles of the preservation of function in the various locomotor systems than with pathological conditions arising in a limited anatomical field. There is quite as much danger of the special departments locking themselves within their own walls as of the major

departments failing to knock at the gates of the special departments. Broad highways should extend from the suburbs to the main city. These roads should be built to stand heavy travel by both business and pleasure cars. There should be two-way traffic and the lights should be continuously green.

George E. Bennett, M.D., Professor of Orthopaedic Surgery, Johns Hopkins University, Baltimore, Maryland

Arthur Krida, M.D., Professor of Orthopaedic Surgery, Bellevue Medical School, New York, N. Y.

Dallas B. Phemister, M.D., Professor of Surgery, University of Chicago, Chicago, Illinois

J. Torrance Rugh, M.D., Professor of Orthopaedic Surgery, Jefferson Medical College, Philadelphia, Pennsylvania

Robert B. Osgood, M.D., *Chairman*, Professor of Orthopaedic Surgery (Emeritus), Harvard University, Boston, Massachusetts

Current Literature

The Life of Sir Robert Jones. By Frederick Watson. London, Hodder & Stoughton, Ltd., 1934. Price 12 shillings, 6 pence.

The appearance of this book has been eagerly awaited in several countries by those who have had an opportunity to know Sir Robert Jones and who have been in touch with his many activities during some period of his life. Not only professionally, but individually he has been so much of an international character that this book will be of international interest.

Probably no one is so well fitted or so well equipped with material as is Mr. Watson to give to the world the story of so illustrious a surgeon and so remarkable a man as Sir Robert Jones. His relationship, which gave to him so intimate a touch, made his task a labor of love and this is evident throughout the book in the use of material which has been available to him because of his family ties. He has used it wisely and has painted the picture with a bold and international stroke which is essential in portraying the likeness of this man who has transcended all national boundaries in his interests and accomplishments. He has told the story so skillfully that one can follow the growth of this unusual man from the beginning. Not often, in a biography, can one follow so intimately the life of a man as in this book and particularly during the early and formative years. Mr. Watson has skillfully traced the influence of Sir Robert's inheritance and of his early environment on the later development of the man. He has shown to the world with an accuracy and fairness, which are a great satisfaction, the characteristics and remarkable traits of character of Sir Robert Jones and particularly the very great humanitarianism which his friends have known and have had the opportunity of seeing in their closer contact with him. Mr. Watson has also shown more than this. He has taken us into the period of Sir Robert's ancestors, and has traced their guiding influence on his character, as well as the shaping of his life through his own management of his early years, and the effect of these factors on his later and mature life. One can trace the general unfolding of his character and traits and their expression in the daily experiences throughout his entire life, and especially their appearance in the time of the larger responsibilities which came to him and to the demands of which he responded with the same capacity and human understanding.

Sir Robert early had the vision to recognize not only the needs of the cripple, but his right to be given a place in the normal community and to be placed in the same plane of responsibility with his normal mates. However, it was not simply the straight thinking of the surgeon, but also the finer instincts of fairness and justice in the man that called him into this field of endeavor and led him to his accomplishments, while he was still so much alone in this difficult path of progress.

His War record was but the continuation, on a tremendous scale, of his methods and of the success which is evident is each period of his early career. Mr. Watson has shown how in later years, when the strenuous work of the World War was over, his activities were in no way abated; and how he set himself to work to make permanent and available to all of his countrymen the information which had been gathered during these years, and to apply to civil life all that vast experience which had been gained during that time. After five years of such endeavor, responsibility, and success, only the broadest field of work could have satisfied him; and the task which he accomplished during this Post-War period in disseminating his information and making it available for the continued demands of civil life was no less in its magnitude, nor was it less important in its benefit to his fellow men.

After reading the book his friends will realize more keenly their loss and will feel still more deeply their affection for the man.

Gelenksteifen und Gelenkplastik (Stiff Joints and Arthroplasty), Part I. By Dr. Erwin Payr. Berlin, Julius Springer, 1934. 120 marks.

In careful, accurate, and thorough fashion the author compiles from his vast experience those observations, views, and conclusions which influence the selection of cases for arthroplasty. "In the correct choice of cases lies for the greatest part the secret of success." Originally, apparently the book was intended to include indications and technique. However, as the author compiled his material, the implications of the problem necessitated, for the sake of clearness and completeness, the inclusion of at least the high points of the normal and pathological biology of joints. The latter, presented in restrained but encyclopaedic chapters, occupies so much space that technique is left for a future second volume.

The book represents the first attempt at an all-inclusive presentation of the problems of arthroplasty. Despite the vastness of the field which the author covers and the inclusion of a tremendous amount of primarily German bibliographical material, it is everywhere a personal document of a critical student and an experienced practical surgeon. Individual workers in the various special fields of pathology and kinesiology might possibly wish that their subjects had been treated in more detail. But to the intelligent surgeon who studies this monumental work, it will be a matter of wonder, as well as satisfaction, that all the fields pertinent to the problems of arthroplasty could have been presented by one man so succinctly and pointedly.

The size of the volume, 880 pages, will probably necessitate its being used primarily as a source of reference and this is rather a pity, since the material contained is so very usable.

The Shoulder: Rupture of the Supraspinatus Tendon and Other Lesions in or About the Subacromial Bursa. By E. A. Codman. Privately printed by Thomas Todd Co., Boston, 1934.

A notable book, this of Codman's, and an important one.

It represents the fruit of thirty years' observation since he first betook himself to the study of shoulders; it represents much intensive work through the years, and, at the end, five years of study and collation of data, and ordering of observations and conclusions.

No one else has done as much as he has in this field and the data here given must be accepted as authoritative.

This volume is destined to take a place with such works as that of Poland on epiphyses, Poirier and Cuneo on bursae, Dwight on anomalies of bones of the hand and foot,—to become one of the books on special subjects with which one must perforce be familiar in order to qualify for discussion of the subject in hand.

Herein is the value of the book, and he who wishes to know of the pathology and course, the diagnosis and treatment, of these conditions, must go to this book.

From a *clinical* point of view the book may be differed with in spots, inasmuch as the graver lesions here emphasized are really rare; but this matters little, as the book will hardly be widely read by general practitioners.

Stiff shoulders, still classified as bursitis, will continue in large numbers to do well with ether manipulation and physiotherapy, or (more slowly) without either.

Now, however, we can have a clearer idea of underlying causes, can segregate and often diagnose the cases with graver lesions,—those calling for surgery.

Suture of supraspinatus tendons will always be resorted to only after grave consideration, until our diagnosis matches our knowledge better, though the results are sometimes admirable.

One has the feeling that open exploration should be done *only* for special reason, and that tapping or submuscular drainage, particularly in acute cases, deserves a larger place than that accorded it here.

But all this is by the way, and the only real word is that of tribute to an unusual record of research.

The curiously personal challenge of the foreword and epilogue of this book cannot be ignored.

Here we have the record of a man of great ability and high ideals.

The establishment of the Registry of Bone Sarcoma and the long, dogged fight for evaluation of our work in surgery in terms of end-result study are the things for which Codman will be remembered as one of the outstanding personal influences of our time.

Every reformer, to be good, must have a smear of the fanatic about him, must be a bit intolerant, not only of opposition but of what seems to him half-hearted support.

"Leave all and follow me" was ever a hard commandment to follow.

As the world goes, it is given to few of us to consecrate ourselves to that uplift in which we none the less believe.

Die Wirbelgelenke. Die Röntgenologische Darstellbarkeit ihrer Krankhaften Veränderungen und ihre Beziehungen zu den Verschiedenen Erkrankungen der Wirbelsäule. Zugleich ein Beitrag zur Pathologie und Klinik der Gesamten Wirbelsäule. Beilageheft zur *Zeitschrift für Orthopädische Chirurgie*, Bd. 61. By Priv.-Doz. Dr. Max Lange. Stuttgart, Ferdinand Enke, 1934. 7 marks.

An extensive study of the small articulations of the spine must be considered an important contribution to our knowledge of those structures. In this volume the author demonstrates, by description and illustration, the pathological changes which may be noted in the small joints, in connection with various diseases and deformities.

The anatomy of the normal vertebrae is presented as it appears on direct and on röntgenographic examination. This, of course, includes the variations at different levels of the spine and also directions for obtaining a proper view of joints in the x-ray photograph.

Attention is directed chiefly to the changes in the interarticular processes, as seen in different forms of arthritis, in scoliosis, kyphosis, lordosis, and fractures of the spine. A very important feature is the critical analysis of the changes seen in the lumbosacral region, and the correlation of these changes with low back pain.

The verbal descriptions are adequately supplemented by clear instructive illustrations,—diagrams, photographs of pathological specimens, and roentgenograms.

This work may well be said to fill an important gap in our knowledge of diseases of the spine.

The Management of Fractures, Dislocations, and Sprains. By John Albert Key, B.S., M.D., and H. Earle Conwell, M.D., F.A.C.S. St. Louis, The C. V. Mosby Company, 1934. $15.00.

The two authors of this volume of 1164 pages are well fitted to collaborate. Key has been able to make important contributions to bone and joint surgery largely through personally conducted research. Conwell for many years has successfully solved the practical problems of the fractures, dislocations, and sprains seen in large industrial hospitals, and often by original methods. Both authors are unhampered by tradition, are clear thinkers, possessing imagination. They have had wide clinical experience and strive to tell "the truth, the whole truth, and nothing but the truth". Whenever their own practice does not fit them to speak with authority, they have called in able surgeons to help them,—as in the chapter on "Fractures of the Skull and Brain Trauma" by Dr. Charles Dowman and in the chapter on "Fractures of the Jaw and the Bones of the Face" by Dr. J. B. Brown.

Excellent reviews of the surgical anatomy precede the discussions of the fractures and dislocations of the different skeletal regions.

The allotment of space seems to be well proportioned to the clinical importance of the subjects under consideration.

Recognizing the increasing importance of industrial accidents with their medicolegal connotations, they have added special chapters on "The Workmen's Compensation Law Affecting Fracture Cases" and on "The Medicolegal Aspects of Fracture Cases". The book is divided into Part I, "General Considerations", and Part II, "Diagnosis and Treatment of Specific Injuries". The illustrations are very numerous, the number exceeding the pages of descriptive text, but they are well chosen and supplement the text in a most helpful manner. The legends are full and unusually explanatory.

Key and Conwell have not simply written one more book on fractures, but, after a wide review of methods, have judiciously evaluated results and with a refreshing frankness have stated their conclusions based on personal experience. The authors seem to have fulfilled the purpose, stated in their preface, of writing a book for the student, the general practitioner, and the surgeon as a practical working guide in the management of fractures, dislocations, and sprains.

L'Enfant. By Léon Dieulafé et Raymond Dieulafé. Paris, J.-B. Baillière et Fils, 1933.

This work represents a most thorough study of practically every phase in the development of the child, and each part is given in the most accurate detail. The morphology, anatomy, and growth are considered in each period of the child's development, and the authors have combined the results of their research with very abundant data from the literature on anatomy, anthropology, medicine, and surgery. This vast amount of data is so well tabulated and arranged that the information given on any particular phase of the subject is easily found, which adds greatly to the value of this book for reference and for study.

The development of the child is first followed from the standpoint of the normal, and, from this basis, the factors are given which produce abnormal or pathological growth. A chapter each is devoted to the skeleton with the joints, the head, and the cavities of the face, the thorax, and the abdomen.

By the study of this book, the physician is better equipped to so guide the development of the child that the individual variations in the constitutional elements may be adapted to the functional demands and the capacity of the individual organism may not be overtaxed. The book is invaluable, particularly for the general practitioner and pediatrician.

Corrective Physical Education. By Josephine Langworthy Rathbone. Philadelphia, W. B. Saunders Company, 1934. $2.50.

On reading this text-book for students of physical education, the somewhat striking title is justified. The book is written for Normal School students and for those graduates who wish to supplement what they obtained in student days. A fundamental knowledge of anatomy and physiology must be presupposed.

This book emphasizes prevention of bodily disabilities and diseases rather than cure. In stressing prevention, good descriptions of a number of orthopaedic and general diseases and disabilities are given and general principles of gymnastic treatment, rather than complete lists of exercises, are outlined. Fundamental principles of physical training are thoroughly portrayed. Postures are defined in anatomical terms and bone-and-joint, muscle, and neuromuscular relationships in standing, sitting, and walking are studied. Human anatomy from the standpoint of kinesiology, neuromuscular fatigue, and faulty postures effected by mechanical abnormalities of the spine are discussed and groups of exercises are given. The author rightly places upon the physician the responsibility of the care of individuals, but shows where the physical trainer may co-operate.

The book contains a full glossary, bibliography, and index. The illustrations include some striking reproductions of classical statuary and a liberal use of so called "ants". The latter are effective when used in conjunction with the description of specific exercises.

This text-book should be of particular value to the student of physical education in that it bridges the gap between the fundamental studies of physical education and the place which systematic and special exercise holds in human therapy. These fundamental principles of physical education should be better understood by physicians, and for those who wish to study in this field the book is valuable. However, for the physician, and especially the orthopaedic surgeon, who wishes lists of specific exercises for definite pathological conditions, the book will be found lacking.

RHEUMATISMUS. By Prof. Dr. Wolfgang H. Veil. Stuttgart, Ferdinand Enke, 1934. 2 marks.

In this booklet of thirty-six pages, a supplement to *Zeitschrift für Orthopädische Chirurgie* (60. Band), the author discusses rheumatism as a generalized disease. A critical analysis is made of the more important theories regarding the etiology, and a large number of clinical disease pictures are brought into close relationship with rheumatism. From the standpoint of social hygiene and constitutional hygiene, the importance of this condition is emphasized by the statement that approximately one-tenth of all patients and invalids are afflicted with rheumatism. Regarding treatment, emphasis is placed on prophylaxis during early life.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Boletines de la Sociedad de Cirugía de Rosario, I, Núm. 1, 1934.

Bulletin of the National Tuberculosis Association (New York), XX, No. 5, 1934.

Medico-Surgical Suggestions (Madras, India), III, Nos. 1–3, 1934.

La Tribuna Médica (Havana), VIII, No. 214–215, 1934.

Universidad Autónoma de Barcelona. Facultad de Medicina: Organización, Régimen de Estudios, Programa de Cursos para el Año 1933–1934.

ON INJURIES OF THE MENISCI OF THE KNEE-JOINT. Oscar Aleman and Sten Friberg. *Acta Chir. Scandinavica*, LXXIV, 319, 1934.

After reviewing 186 cases of injury of the semilunar cartilages, the writers present this old subject in a refreshing way. There were 160 medial and twenty-six lateral cartilage injuries. The material was from a military hospital and, therefore, not suitable for statistical study other than tabulation of the types of injury. The writers are skeptical of the existence of the hypermobile cartilage. They do include superficial rupture and splitting into layers, however. There were three cysts of lateral cartilages.

The mechanism, clinical findings, and diagnosis are carefully studied. Rupture of the medial cartilage must be differentiated from chondromalacia patellae, which closely simulates it. Lesions of the lateral cartilage are more easily diagnosed than those of the medial. Localized swelling over the lateral joint line, just in front of the collateral ligament, is a very important sign.

All of their diagnoses are confirmed by operation. If no definite tear is found, the cartilage is not removed. An anterior parapatellar incision is used, and frequently in the case of the lateral cartilages and occasionally in the medial cartilages a posterior incision is also used. The authors prefer to leave in a rim of cartilage rather than to take out the whole thing, and have even devised a knife for splitting it longitudinally. A "ring-knife" is used on the medial cartilages much as a tonsil snare is used by some surgeons in America for cutting the posterior end. An Esmarch bandage is not used in cases of patients over forty-five years for fear of thrombosis. The knee joint is kept immobilized for eight or ten days and full use is allowed in four or six weeks. The follow-up examinations are tabulated.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Osteochondritis Dissecans Capituli Humeri. N. Aage Nielsen. *Acta Orthop. Scandinavica*, IV, 307, 1933.

This monographic article of 140 pages reviews the literature of joint mice, beginning with Paré, and then analyzes the writer's cases in detail. He has observed 133 patients with osteochondritis dissecans of the capitellum, a total of 168 elbows of which fifty-six were operated upon. Roentgenographic examination of 1000 males taken at random from the vicinity showed an incidence of this malady of four and nine-tenths per cent. From this wealth of material the writer arrives at numerous conclusions, some of which are as follows:

Osteochondritis dissecans capituli humeri is almost entirely limited to males, and is most common among those engaged in physical work. Trauma plays no definite etiological rôle, and there is no evidence to support the theories that endocrine disturbances, nervous disorders, or rickets are responsible. There is a striking similarity between this disease and coxa plana, Köhler's, and Kienböck's diseases. It is an aseptic bone necrosis occurring at a definite location, often bilaterally symmetrical, at a certain period in the development of the individual, almost always between the ages of thirteen and seventeen, and with a definite relation to sex and heredity. Subjective symptoms are not always present. Operative removal of free bodies is indicated when they cause pain or disability, but good results cannot be ascribed solely to the operative procedure, for symptoms may disappear with spontaneous healing. There is no justification for the theory that operation lessens the extent of the deforming arthropathy.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

The First Stages of Coxa Plana. Henning Waldenström. *Acta Orthop. Scandinavica*, V, 1, 1934.

After twenty-five years of writing on the subject of coxa plana, Waldenström contributes this study of the earliest stages of coxa plana. He divides the development of the lesion into a pre-coxa-plana stage, the initial stage lasting six months to a year, and the succeeding stage of fragmentation, lasting two to three years. In his studies are included pathological specimens from a boy who died at fourteen years of age after suffering for eight years with coxa plana. The writer also presents numerous serial roentgenograms, some of them taken several years before the onset of the bone changes. He finds that the flexion-abduction position of Lauenstein shows the early changes much more readily than the anteroposterior view.

Contrary to the views of Murk Jansen and Calot, the writer finds that coxa plana develops in hip joints which previously have been normal. This is shown in a case of bilateral coxa plana where the second hip, which is normal in the first two roentgenograms, shows the typical changes after three years. The symptoms are present several months before the roentgenograms show changes. The earliest diagnostic sign is flattening of the epiphysis. This has been observed by the writer one month after the appearance of symptoms. The distance from the medial part of the epiphysis to the bottom of the socket,—*i.e.*, the lateral leg of the U-shaped figure, is also greater than normal. This distance increases with the progression of the disease. At first the shape of the acetabulum is normal. Later it changes to adapt itself to the deformed head. When the adaptation is complete, the distance of the epiphysis to the bottom of the acetabulum becomes normal again.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

Ueber Verletzungen der Ligamenta Cruciata des Kniegelenkes und Deren Behandlung (Injuries of the Crucial Ligaments and Their Treatment). Nils Silfverskiöld. *Acta Orthop. Scandinavica*, V, 35, 1934.

A knee injury diagnosed as injury of the crucial ligaments was treated by aspiration and fixation for eight weeks, with complete recovery. Another patient with avulsion of the tibial spine and rupture of both semilunar cartilages was operated upon with a good

functional result. In a third case, a posterior crucial ligament was repaired by transplant of the semitendinous and half of the semimembranous tendons which were also used to reinforce the collateral ligaments. Nine months later there was good stability with ninety degrees of motion. The writer emphasizes the value of conservative treatment in the early case.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

VERSUCHE EINER DEUTUNG DER PATHOGENESE DER SKELETTVERÄNDERUNGEN BEI CHONDRODYSTROPHIA FOETALIS (The Significance of the Pathogenesis of the Skeletal Changes in Chondrodystrophia Foetalis). Ake Wilton. *Acta Path. et Microbiol. Scandinavica*, Supplementum XV, 1, 1933.

A beautifully prepared monograph of more than 160 pages presents the subject of chondrodystrophia from all angles. Four foetal preparations showing this deformity are presented. After an exhaustive study of the histopathological changes, the writer concludes that chondrodystrophia foetalis is *in fact* foetal rickets and should be called by its original name. The argument is rather involved for an orthopaedic surgeon, but should delight the heart of a pathologist.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

UNION OF PATHOLOGICAL FRACTURES FOLLOWING METASTATIC HYPERNEPHROMA. Edwin L. Rypins. *Am. J. Cancer*, XX, 601, March 1934.

The author reports a case of a patient forty-six years old with a large hypernephroma of the right kidney, treated by nephrectomy. About a year later, an extensive osteolytic tumor appeared in the mid-part of the left ulna which was treated with 1000 roentgen units. The patient later sustained a pathological fracture of the tibia through another metastatic focus. No x-ray therapy was used over the tibia. Six months later roentgenographic examination showed definite healing of both the tibia and the ulna, with bony union of the pathological fractures.

In discussing the case, the author states that a careful search of the literature failed to disclose any other case of metastatic hypernephroma of the skeleton which showed union following pathological fracture. Radiation therapy may have influenced healing of the fracture of the ulna, but the tibial fracture healed without such treatment.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

MODERNE BEHANDLUNG UNKOMPLIZIERTER KOMPRESSIONSBRÜCHE DER BRUST- UND LENDENWIRBELSÄULE. MITTEILUNG ÜBER DIE BEHANDLUNGSERGEBNISSE DER WIRBELSÄULENBRÜCHE NACH WATSON-BÖHLER (Modern Treatment of Uncomplicated Compression Fractures of the Dorsal and Lumbar Spine. Report of Results of Treatment of Spinal Fractures According to Method of Watson-Böhler). Fritz Felsenreich. *Arch. f. Klin. Chir.*, CLXXVI, 123, 1933.

As a result of clinical and pathological anatomical observations, the following basic principles have been developed:

1. In the majority of compression fractures of the vertebrae, the ligamentum longitudinale anterius and the ligamentum longitudinale posterius are intact and the intervertebral discs are in firm union with these ligaments.

2. The posterior portions of the vertebral bodies are mostly intact, and the spinal cord in these cases is protected by the integrity of the ligamentum longitudinale posterius.

3. The articular processes are fractured only in exceptionally severe cases and the vertebral body is subluxated or dislocated.

4. The ligamenta interspinalia are torn and the spinous processes are fractured or further separated from each other.

5. The spinal column shows a pathological flexion angulation, with a forward shifting of the center of gravity.

From these principles it is concluded that it is possible, by reclination, with or

without traction, to reduce the subluxated joints and to restore the axis of the spinal column.

Following the method of Böhler, the author treated, within nine months, twenty-four patients with fracture of the dorsal or lumbar spine. Fractures above the ninth dorsal vertebra could not be influenced by this treatment.

During the course of fracture of the spine, four stages are distinguished:

1. The stage of immediate traumatic shock.
2. The stage of retroperitoneal hematoma, manifested by abdominal and circulatory disturbances.
3. The stage of consolidation of the fracture.
4. The stage of adjustment of the rest of the column and the entire motor apparatus to the altered vertebra.

The first stage may last from several hours to two days and it is characterized by changes which are produced by fat embolism. Practically, it is very important to recognize this stage as its close is the most favorable time to effect reduction.

The second stage is characterized by symptoms resulting from the fracture hematoma. The main feature is an ileus, often accompanied by embarrassment of the circulation and respiration. This stage may last from eight to fourteen days. If reduction of the fracture cannot be completed before the onset of this stage, it is preferable to delay the reduction until this stage has passed.

The third stage is that of consolidation of the fracture, and it is generally estimated to be the period from the third to the sixteenth week after injury. It is during this stage that activation of the muscles should be instituted to prevent atrophy.

The fourth stage begins with the transition from the reclining to the upright position of the patient, and corresponds to the period during which adaptation to an altered position of the spine takes place. It is during this stage that functional treatment of the spine and of the whole body is emphasized.

Reposition of the fracture is carried out under spinal anaesthesia. The patient is suspended between two tables to obtain the maximum degree of lordosis of the spine. Retention is by means of a plaster cast, unpadded, except at the point of maximum lordosis posteriorly.

The technique of reduction and application of the cast are described in minute detail.

Functional treatment in the form of gymnastics may be instituted eight to ten days after reduction. The length of time required for union varies from six weeks to five months.

Case reports are given of twenty-four patients, treated by this method.

Further comments by the author emphasize the possibility of reduction of fractures of the spine, the possibility of retention, the advantages over the purely functional method of treatment, and the possibility of shortening the fourth stage of the injury.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

WEITERE ERFAHRUNGEN BEI DER BEHANDLUNG VON WIRBELBRÜCHEN (Further Experiences in the Treatment of Fractures of the Spine). Lorenz Böhler. *Arch. f. Klin. Chir.*, CLXXVII, 424, 1933.

The author emphasizes the possibility of reducing compression fractures of the spine within two weeks after injury.

If a gibbus develops as a result of spinal fracture, and can no longer be corrected, the treatment should be directed toward a realignment of the rest of the spine. The cause of symptoms following a fracture of the spine is the malalignment of the column, and the severity of the symptoms is directly proportional to such malalignment. Faulty alignment of this type can be corrected within eight weeks after the injury.

The reduction is done under local anaesthesia, according to the method of Schnek. Hyperextension of the spine is produced with the patient in the prone position. An

unpadded plaster cast is applied to maintain correction. In case of paralysis with spinal fracture, this treatment is also effective and is preferable to a laminectomy.

In fractures which show an angulation of the spinal column up to twenty degrees, three months are required for solid union. Where the angulation is greater than twenty degrees, four months or more are required.

One or two days following reduction and application of the cast, the patient is required to perform systematically a number of exercises designed to activate the muscles and also as a psychic stimulus.

This report is based on observation and treatment of eighteen cases. A comparison is made between the results of this method of therapy and those of other methods. The resulting disability is much less than that obtained by other writers, using different forms of treatment.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Spätschädigungen im Gebiete des Nervus Ulnaris nach Ellbogenverletzungen bzw. Arthritis Deformans mit Besonderer Berücksichtigung der Unfall-Begutachtung (Late Lesions of the Ulnar Nerve, Following Injuries to the Elbow, or as a Result of Arthritis Deformans, with Particular Reference to Compensation Reports). Collin. *Arch. f. Orthop. u. Unfall-Chir.*, XXXIII, 551, 1933.

This article is of importance, since, after an extensive experience with paralysis of the ulnar nerve, Dr. Collin has been able to show that in a large percentage of cases the nerve symptoms are not due to injury to the elbow, but to an arthritis which has developed independently of trauma. He lists four conditions which must be met before the paralysis can be attributed to the injury:

1. There must be definite evidence of an injury to the elbow.
2. The injury must be of sufficient severity to cause the injured person to be declared sick, and to have medical attention.
3. The joint injury must not have occurred ten or more years before.
4. Only the injured joint may show evidences of arthritis.

In every case it is advisable to take x-rays of the numerous other joints, in order to determine whether the arthritic changes are due to local or general causes.

Dr. Collin calls attention, however, to one type of arthritis which can properly be attributed to industrial injury,—namely, that occurring in workers who use compressed-air instruments. He reports two cases where, under these conditions, there was definite evidence of localized arthritis of the right elbow, with a complicating ulnar nerve involvement.—*Leo Mayer, M.D., New York, N. Y.*

Winkelbildung am Proximalen Femurende Zwecks Korrektur der Fehlerhaften Funktion des Verrenkten Hüftgelenkes (Change of Angle at the Proximal End of the Femur for the Correction of Malfunction of the Dislocated Hip). Eugen Kopits. *Arch. f. Orthop. u. Unfall-Chir.*, XXXIII, 586, 1933.

This paper is based on a study of forty-seven patients with dislocation of the hip, thirty-nine cases being of the congenital type. Seven of the patients with congenital dislocations had bilateral dislocations. Kopits made a careful study of the end results following the bifurcation operation of Baeyer and Lorenz. He found that the good results were not due to the impinging of the distal fragment against the *acetabulum*, since, as shown by control roentgenograms, this fragment of the femur was found invariably to have atrophied and finally to have entirely disappeared. He, therefore, modified the bifurcation operation in such a way as to eliminate the shortening due to the original setting of the distal fragment.

The line of the osteotomy is made in much the same direction as in the original operation. The distal fragment, however, is made to impinge against the cut surface of the proximal fragment at its upper tip, instead of being shoved forward and inward, so that the lateral surface of the femur comes in contact with the cut lower end of the

proximal fragment. The proximal fragment is held adducted as far as possible, and the plaster is applied in two steps, by the method of Dollinger, so as to maintain the fragment in the adducted position, while the distal fragment is held abducted at an angle of forty degrees.

Kopits reports a number of gratifying results. Although a slight limp is still present. the Trendelenburg sign disappears and there is a marked improvement in the patient's gait.—*Leo Mayer, M.D., New York, N. Y.*

RELATIONSHIP BETWEEN ANATOMIC CHANGES IN KNEE JOINT WITH ADVANCING AGE AND DEGENERATIVE ARTHRITIS. Chester S. Keefer, Frederic Parker, Walter K. Myers, and Ralph L. Irwin. *Arch. Int. Med.*, LIII, 325, March 1934.

A systematic study was made of 100 knee joints removed at seventy-seven consecutive necropsies, in order to obtain information in regard to changes which may be encountered with advancing age.

The only cases excluded from the group studied were those in which there was a definite infection of the joints, as determined by bacteriological examination of the joint fluids.

There were no symptoms referable to the joints recorded in the clinical histories of sixty-six patients, and pain and stiffness were present in only eleven of the seventy-seven patients. The patella showed alterations in eighty-one per cent. of the cases, the interpatellar groove in eighty-five per cent., the lateral condyle of the tibia in sixty-four per cent., the medial condyle of the tibia in fifty-five per cent., the medial condyle of the femur in forty-three per cent., and the lateral condyle in thirty-six per cent.

An analysis of the mechanics of the knee joint showed that alterations were most common over the areas of contact which were subjected to the greatest movement, strain, weight-bearing, and injury. The alterations varied greatly in character and degree. In some instances there was simple fibrillation of the cartilage with irregularity of the surface; in other cases there was loss of varying amounts of cartilaginous substance, so that occasionally the underlying bone was exposed. When the bone was exposed it gave the appearance of so called eburnated bone. These changes increased in frequency with advancing age. In the fifth and following decades they were present in ninety to 100 per cent. of the cases. It is difficult to escape the conclusion that these changes are precisely the same as those described as being characteristic of so called degenerative arthritis.

The alterations in so called Charcot's joints must be regarded as the result of frequent traumata to joints which have been rendered insensitive to pain by a nerve lesion. Changes in the joints in patients with hemophilia, brought about by repeated trauma and hemorrhage, are often indistinguishable from those of degenerative arthritis.

There is justification for the belief that degenerative arthritis is a process associated with aging of the tissues of the joints. Added to the process of involution, such factors as gross trauma, hemorrhage, and static deformities exaggerate the condition. The end result depends on the summation of these factors.—*Clark W. Heath, M.D., Boston, Massachusetts.*

DIE SUBLUXATION DES HÜFTGELENKS INFOLGE ENTWICKLUNGSHEMMUNG DER PFANNE (Subluxation of the Hip Joint as a Result of Developmental Arrest of the Acetabulum). B. Simons. *Beitr. z. Klin. Chir.*, CLVII, 505, 1933.

Six cases are reported as they appear in childhood and adolescence, and three cases as seen in middle age. This condition may be bilateral or unilateral, may be associated with congenital dislocation of the hip, and may show, in addition, either a coxa vara or a coxa valga. The most common clinical feature is a limp and this is commonly associated with pain in the hip, at times quite early in life.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Richtlinien und Physiologische Grundlage der Functionellen Behandlung Unkomplizierter Wirbelbrüche (Physiological Basis of Functional Treatment of Uncomplicated Fractures of the Spine). Hans Kraus. *Deutsche Ztschr. f. Chir.*, CCXLI, 553, 1933.

The basic principle of present-day fracture treatment—reposition, fixation, and functional treatment immediately following successful immobilization—is applicable also to fractures of the spine. Functional treatment of spinal fracture, according to the author's conception, consists exclusively of active exercises, which are to be instituted after reduction and fixation of the fractured part in a plaster cast. Such exercises are indispensable for a satisfactory result, and they are to be continued as long as possible, at least for one year. Such active exercises serve to strengthen the entire musculature, to eliminate arrested movement produced by the cast, and to restore the normal condition of the musculature, which has been placed in an unphysiological attitude and primarily traumatized. Psychotherapy and the prevention of a compensation neurosis are the main features of the plan of treatment. After fixation in the plaster cast, the patients are no longer in need of hospitalization. After removal of the cast, a short period of guarded activity may be followed by light work; and, depending upon the severity of the condition, the patient may in a few months undertake heavy work.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Double Pulley Traction in Fractures of the Shaft of the Humerus. Report of a Case. Lester Blum. *J. Am. Med. Assn.*, CI, 1953, 1933.

The method previously used at the Beekman Street Hospital has been adhesive traction to the arm with the forearm suspended at right angles. In muscular patients, or in cases of compound fracture, the adhesive was replaced by pin traction through the olecranon. Slipping of the adhesive plaster and irritation of the skin constituted real problems. The functional results obtained were good, but the anatomical results were only fair to poor.

The principles of Russell's method of traction for fractures of the femur are now applied in the treatment of fractures of the humerus and the apparatus is made so as to attain accurate axis traction on the upper extremity. The traction is obtained through adhesive plaster applied to the forearm.

The apparatus consists of a well padded cuff which partially encircles the elbow, with its pressure broadly distributed over the skin of the cubital fossa, a continuous length of rope, a series of three pulleys, and a hand spreader. Two forces are projected,—the greatest is upward, is transmitted through the hand spreader, and is equal to twice the suspended weight; the second force is downward, is transmitted through the cuff in the cubital space, and is equal to the suspended weight.

Advantages of the method are: (1) accuracy of the traction; (2) ability to elevate the patient's head without disturbing the position of the fracture; (3) freedom of the arm, especially important in a compound fracture; (4) anaesthesia or operation unnecessary.

One case is reported which has been successfully treated by this method.—
W. B. Carrell, M.D., Dallas, Texas.

Stiff, Painful Shoulders, Exclusive of Tuberculosis and Other Infections. Edson B. Fowler. *J. Am. Med. Assn.*, CI, 2107, 1933.

The article is devoted to: (1) a review of synonyms; (2) an analysis of pathology; (3) a study of the rôle of rupture of the supraspinatus tendon, capsule, and bursa as an etiological factor; (4) a review of a few cases; (5) a brief outline of treatment; (6) an outline of a simple operation for tendon and capsule repair.

The purpose of the article is to direct attention to evidence that rupture of the supraspinatus tendon is apparently the primary exciting cause of most stiff, painful shoulders. Codman found complete rupture of one in every twenty shoulders examined

at autopsy and one partial rupture in every third shoulder. In a study of 340 shoulders, the author found one complete rupture in every twenty-eight shoulders examined and one incomplete rupture in every six shoulders. Deposits were found in more than one-third of the cases of rupture. These deposits were in and about the supraspinatus tendon. In the absence of tear, no degenerative changes were found.

Codman believes that all ruptures of the supraspinatus tendon are caused by contraction of the supraspinatus muscle and that tear is rarely due to direct trauma. The rupture may be complete after one insult, or may be gradual in cases of chronic strain upon the tendon. Care in taking the history of these cases in great detail is of the utmost importance as it will often be disclosed that there has been sudden stress placed upon the tendon, or that there has been long continued overuse.

In the light of this evidence, exploration of the shoulder under local anaesthesia is easily justifiable, especially where no etiology can be established and no improvement has occurred under conservative measures. The operation is done under local anaesthesia in the first stage and the supraspinatus tendon is inspected.

In the case of a rupture, repair is done under general anaesthesia. The first skin incision is extended and the acromion is cut through from without inward, beginning half an inch behind the acromioclavicular joint. Retracting this fragment forward exposes the ruptured tendon. The greater tuberosity is drilled and then, with the arm in abduction, the ruptured tendon is made secure to the greater tuberosity with linen or silk sutures. After two weeks, the arm is lowered to a sling and gradual use is encouraged as the soreness from the operation subsides.—*W. B. Carrell, M.D., Dallas, Texas.*

Familial Neurotrophic Osseous Atrophy. A Familial Neurotrophic Condition of the Feet with Anesthesia and Loss of Bone. E. Maurice Smith. *J. Am. Med. Assn.*, CII, 593, Feb. 24, 1934.

This unusual clinical condition has been observed in two generations of a family and there is a definite history of its existence in a third generation. The condition is characterized by ulcers on the plantar surface of the feet and toes, with anaesthesia and loss of bone.

Six cases are reported,—one son by the father's first marriage, two sons by his second marriage, and three sons of the first patient mentioned.

Syphilis, tuberculosis, and syringomyelia were ruled out. A consultant with a wide experience in treating leprosy thought the condition not of that etiology.—*Ike Kendrick, M.D., Dallas, Texas.*

Delayed Appearance of Deformity in Vertebral Body Fractures. O. O. Feaster. *J. Am. Med. Assn.*, CII, 599, Feb. 24, 1934.

Low back pain may be a sequela of an undiagnosed compression fracture. The trauma necessary to produce a compression fracture may be surprisingly insignificant. Roentgenograms taken after an injury may not show a compression fracture, but those taken a few hours to several days after the injury may show well defined deformity of the vertebral body. At the time of the injury the disturbance of the nutrition and homogeneity of the bone is not sufficient to deform the body at the time, but predisposes the body to deformity and so weakens its structure that the patient's weight or movements causes the weakened body to collapse and so accounts for the typical roentgenographic picture at a later examination. The persistence of symptoms after an injury is absolute indication for the taking of further roentgenograms of the spine, including a lateral view.

The so called cases of Kümmell's disease probably fall into this group of cases, and it is seriously doubted that Kümmell's disease should be considered as a disease entity.

It is pointed out that the fracture may exist from five to seven vertebrae above the site of pain.—*W. B. Carrell, M.D., Dallas, Texas.*

SECOND ATTACKS OF POLIOMYELITIS. REVIEW OF THE LITERATURE AND REPORT OF A CASE. T. B. Quigley. *J. Am. Med. Assn.*, CII, 753, March 10, 1934.

It is probable that no infectious or contagious disease confers *permanent immunity*. Second attacks of almost all such diseases have been reported.

Fourteen cases in which second attacks of acute poliomyelitis have occurred are recorded in the literature. These second attacks must be distinguished from relapses. Still has observed that the relapses almost invariably occur within three months.

The interval between the longest reported relapse and the earliest true recurrence is two years. The interpretation of the significance of this period cannot now be decided, but, as has been suggested, it probably represents the minimum duration of immunity.

Eleven of the fourteen cases reported in the literature appear to be reasonably definite. Still's tabulation of these eleven cases lists an interval of from two to twenty years between the attacks.—*W. B. Carrell, M.D., Dallas, Texas.*

THE INCIDENCE AND PATHOGENESIS OF DEGENERATIVE ARTHRITIS. Chester S. Keefer and Walter K. Myers. *J. Am. Med. Assn.*, CII, 811, March 17, 1934.

In determining the incidence of chronic degenerative arthritis, three general methods are used: (1) post-mortem examination of the joints; (2) roentgenographic examinations; (3) determination of the number of patients having symptoms referable to the joints. Of these three methods, the first is by far the most satisfactory. In order to gather more precise information, 150 knee joints were examined.

Lesions were found to increase with age, and the areas showing the most striking changes were those subjected to the most weight, movement, pressure, and trauma. In the knees examined, the areas involved were in order of frequency: (1) the patella; (2) the intercondylar areas of the femur; (3) the condyles of the tibia; and (4) the condyles of the femur. The frequency of changes also increases with age. Between the ages of twenty and forty years, sixty per cent. of the patients showed defects; between forty and fifty years, ninety-five per cent.; and 100 per cent. of older patients.

What has been said of the knee joint also applies to other joints, especially to the joints of the spine. All observers have agreed that the condition increases with age.

In addition to age, the condition is influenced by occupation, static deformities, and trauma.

Trauma to joints, such as in joint fractures, and hemorrhages into joints, as in hemophilia, and repeated injuries to joints, as in tabes dorsalis and syringomyelia, are the causes of alterations in joints giving the picture of degenerative arthritis.

From a gross and histological view-point, the evolution of the process is as follows: As a result of the aging of the cartilage or of gross trauma, the cartilage loses its elasticity and becomes split or fibrillated in the vertical plane. Following this change, the damaged cartilage no longer protects the subchondral plate of bone from pressure, weight and impacts, as does normal cartilage. Following the loss of the cartilage, the underlying bone becomes very dense and the surface highly polished. The marginal spicules seen in these joints are not due to bony overgrowth, but to depression of the normal joint line, so that the edge projects over the margin of the bone like a mushroom.

The authors conclude that degenerative arthritis increases with age, and that anatomical changes are due to wear and tear and not to any particular disease process.—
Ike Kendrick, M.D., Dallas, Texas.

CREPITANT ANTESCAPULAR BURSITIS. V. A. Astrakhanski. *New Surg. Arch.* (U.S.S.R.), XXIX, 3, 1933.

The crepitation observed in these cases is due to a proliferative bursitis, developed over an exostosis on the anterior surface of the scapula. The affliction is a definite clinical entity and should be differentiated from other diseases of the costoscapular region A pathognomonic sign is described by the author. On deep inspiration and expiration

the intensity of the crepitation diminishes; on moderate inspiration, the crepitation is more intense. This is not observed in any other condition around the shoulder. The treatment is surgical and consists of the removal of the inflamed or calcified bursa and a plastic covering of the denuded area.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE OPERATIVE TREATMENT OF CALCANEAL SPURS. N. Markelov and A. Illin. *Orthopaedia i Travmatologia*, VII, No. 1, p. 49, 1933.

The authors observed thirty patients, twenty of whom gave a history of Neisserian infection. As a rule, the pain in the heel appeared from three to eight months after the onset of the acute infection. The pain is caused by periostitis of the spur, with bursitis. Ten of the thirty patients had associated pes planus. Seventeen patients underwent operation. The operative technique is simple. Under local anaesthesia, a horizontal horseshoe incision is made encircling the heel; the flap is thrown down and the spur is removed by chisel. The wound is closed without drainage. No simultaneous operative procedures for the improvement of any other condition of the foot are advised. The postoperative results are very satisfactory.—*Emanuel Kaplan, M.D., New York, N. Y.*

THE CLINICAL COURSE AND PATHOLOGICAL ANATOMY OF THE HYDATID ECHINOCOCCOSIS OF BONES. M. Khovenko and K. Elenvsky. *Orthopaedia i Travmatologia*, VII, No. 2, p. 3; No. 3, p. 1, 1933.

In a detailed study, the authors review the literature of this affliction and describe four cases observed and treated by them. The patients did not have much contact with dogs; their disease had a protracted course. The correct diagnosis was suspected in a single case only. No eosinophilia was observed. Two patients were operated on. In one case, in which the knee was involved and subsequently proved to be echinococcic, the roentgenographic and the gross operative aspects were typically tuberculous.

The authors conclude that the positive clinical and roentgenographic diagnosis is difficult. They find that the bone reacts differently to the hydatid and multilocular echinococcus. The hydatid type gives a more benign course. The multilocular type always produces emaciation and simulates tuberculosis. Weinberg's test seems to be diagnostically reliable. An early recognition of the disease, with a timely and extensive operation, ought to give favorable results.—*Emanuel Kaplan, M.D., New York, N. Y.*

A COMPARATIVE ANALYSIS BETWEEN THE PATHOGENESIS OF OSTEODYSTROPHIES AND BONE TUMORS. Isaac Levin. *Radiology*, XXII, 266, March 1934.

Tumors of the bone may be indistinguishable morphologically and roentgenographically from inflammatory, metabolic, or endocrine diseases of the bone. Primary sarcoma, metastatic carcinoma, osteomyelitis, syphilis of the bone, and the various types of osteodystrophies may present pictures so similar that a differential diagnosis becomes impossible. Von Recklinghausen came to the conclusion that osteitis fibrosa presents close analogies with Paget's disease of the skeleton and osteomalacia on the one hand, and with metastatic carcinoma of the skeleton on the other.

There are two classes of skeletal metastases of carcinoma: osteoplastic, in which extensive new bone formation takes place around the metastatic tumor; and osteoporotic, in which the changes in the normal tissues surrounding the metastasis consist of destruction of the compact bone. The microscopic study of the cases analyzed by the writer showed that both conditions were generally present side by side. The differences in the gross appearance are due to the fact that in one case osteoplasia, or new bone formation, predominates, while in another osteoporosis, or the destruction of the old bone, is mainly in evidence.

Osteitis fibrosa and osteitis deformans appear to be morphologically and roentgenographically similar to osteoplastic metastatic carcinoma of the skeleton. There

must also be, therefore, some similarity in the mechanism of the formation of the two conditions.

It is significant that the types of carcinoma which most frequently develop metastases in the bones are carcinoma of the breast, of the prostate, and of the thyroid,—*i.e.*, organs with active endocellular metabolism and endocrine functions.

The destruction of normal bone tissue (osteoporosis) in skeletal metastasis is a purely local process and, as already stated, must be a direct function of the group of cancer cells transported to the bone. This function is most probably chemical, in accordance with Von Recklinghausen's conception, and the resultant change in the bone, as he thought, is analogous to the condition found in osteomalacia.

The new bone formation (osteoplasia) is undoubtedly an attempt at self defense—a reactive or reparative process—and the mechanism of its formation is identical in all types of bone tumors or osteodystrophies.—*Edward N. Reed, M.D., Santa Monica, California.*

HIP JOINT CHANGES IN HEMOPHILIA. Max Kahn. *Radiology*, XXII, 286, March 1934.

Schloessman estimates that one-third of all hemophiliacs are free from joint symptoms, whether sporadic cases are examined or whether the members of a single family of males are investigated.

The usual onset of symptoms is in the first or second year, following the small injuries to which the joints are normally subjected. Many cases, however, appear to have their onset just before adolescence, between the ages of nine and thirteen years. Apparently hemorrhages in the region of the joints, which are responsible for the hemophilic arthropathy, may, in some cases, occur spontaneously. The knee joint is by far the most frequently involved, followed in the order of their frequency by the elbow, ankle, and hip joints. The hands and shoulder joints are rarely involved. In isolated instances, the fingers or the temporomandibular joints may be affected.

In the first or second year of the joint disturbance, the roentgenogram is usually negative. Later, when limitation of motion occurs in the joint, the roentgenogram will show atrophy of the neighboring bones. This is followed by destruction of the joint surfaces, with periarticular irregularities, resembling arthritis deformans. The joint cartilage disappears and the joint surfaces approach each other. Synostosis may occur. Accompanying these intra-articular changes, there are usually periarticular manifestations. The earliest of these may be a hazy shadow in the soft parts, caused by periarticular hemorrhage, which later may be followed by calcification and ossification. The bones about the joints become enlarged and broadened across their articular surfaces.

In the early stages, the roentgenographic changes may resemble those of tuberculosis, osteochondritis, or coxae juvenilis; later they simulate osteitis deformans. The family history and the patient's past history of bleeding are the most important factors in the differential diagnosis. Another point of differentiation is the short duration of pain, which in the hemophilic joint subsides after four to six days.

Key is of the opinion that bony ankylosis does not occur in hemophilic arthritis. He states that the changes in the cartilage, which are characteristic of a hemophilic joint, have a map-like appearance, due to cartilage destruction, and that the characteristic change in the bone is the formation of cavities in the intra-articular portion. He believes that bone destruction does not occur until late in the disease, and that at some stage of the disease the bone becomes markedly atrophic as a result of disuse. The areas of bone destruction are frequently so extensive that they are clearly visible in the roentgenogram.

Marked hemarthrosis, due to bleeding from the synovial membrane or periarticular structures within or about the joints, is most common in the region of the knee or elbow. Roentgenographically, however, changes about the hip joints of hemophiliacs are rare.

Recently a case of hemophilia was treated by intramuscular injection with ovarian extract, with an excellent result. Birch is credited with the discovery that a hormonal disturbance exists in hemophilia which is temporarily relieved by parenteral administration of ovarian substances.—*Edward N. Reed, M.D., Santa Monica, California.*

De L'Arthrodèse de la Hanche Dans le Traitement de la Coxalgie et Son Dangereux Équivoque (Arthrodesis of the Hip in the Treatment of Coxalgia and Its Uncertain Results). Jacques Calvé. *Rev. Med. Française*, XV, 225, 1934.

Dr. Calvé discusses the subject of arthrodesis of the hip in the treatment of tuberculous coxitis largely from the standpoint of the conservative French orthopaedic surgeon. He emphasizes the fact that attention must be given to four principles in the treatment advocated by most of the conservative orthopaedic surgeons in the larger centers, such as Berck, Leysin, etc.: (1) hip disease is but a local manifestation of general disease; (2) strict immobilization of the focus is necessary during the acute period of the disease; (3) the cold abscess must be considered frequently as a concomitant of the disease and should not have surgical treatment by opening; (4) a closed tuberculous focus should never be opened surgically.

He discusses the principles in general and gives statistics which have been obtained from the two methods of treatment,—the conservative method in his own Clinic at Berck; and the operative method in the Clinic of Vignard at Lyon. A comparison of the two methods shows far more favorable results obtained by the conservative treatment, both in regard to the number of cures and, particularly, the number of persistent fistulae.

He then compares the statistics given by different authors in the literature and emphasizes the need of distinguishing between extra-articular arthrodesis and intra-articular arthrodesis. He feels that intra-articular arthrodesis should never be used, since it opens into the focus of disease, but that extra-articular arthrodesis has its place in the treatment of these cases.

Fractures and Dislocations of the Tarsal Bones. Philip D. Wilson. *Southern Med. J.*, XXVI, 833, 1933.

This paper is based upon a study of 4,536 cases of fractures and dislocations treated at the Massachusetts General Hospital between 1923 and 1930. In practically two per cent. of the cases the tarsal bones were involved.

Severe cases of fracture of the os calcis with involvement of the subastragalar joint are best treated by subastragalar arthrodesis at the end of three weeks, unless a very accurate reduction has been obtained by manipulative methods.

The author stresses the importance of careful diagnosis, accurate reduction, and proper after-care for successful results in these important weight-bearing structures.—
F. G. Hodgson, M.D., Atlanta, Georgia.

Non-Operative Versus Operative Treatment of Tuberculosis of the Spine in Children. J. H. Kite. *Southern Med. J.*, XXVI, 918, 1933.

The author gives the results of fifty cases treated by each method at the Scottish Rite Hospital in Decatur, Georgia. The patients were all treated alike in regard to rest in bed, good food, fresh air, and sunshine.

The operations in the past three years have been done under local anæsthesia. If it is necessary to fuse more than six vertebrae, the operation is done in two stages. The Hibbs method is used.

In the non-operated group of fifty cases, an excellent result was obtained in only one case. Satisfactory results were obtained in seven cases. Fourteen cases showed improvement; eleven cases no improvement.

In the operated group of fifty cases, excellent results were obtained in thirty-four. These thirty-four cases were the only ones in which adequate operations had been performed. Thirty per cent. of the patients had inadequate fusions and required further operations.

There was only one operative death which occurred in the early days of spine fusion. In the group in which the patients had had inadequate operations, there was one death two and one-half years after operation and one six and one-half years after operation.

There were no deaths among the thirty-four patients who had had adequate operations.

This is an excellent article and is well illustrated.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

TREATMENT OF FRACTURES IN THE LOWER THIRD OF THE LEG. W. B. Carrell. *Southern Med. J.*, XXVI, 1054, 1933.

This is a consideration of 100 cases in which satisfactory results were not obtained by the usual methods of treatment. There were twenty-three cases of compound fracture, twenty of incomplete reduction, seventeen of malunion, twenty-three of non-union, and seventeen of delayed union. From a study of these cases the author draws the following conclusions:

1. Early reduction and gentle manipulation will reduce circulatory complications.
2. Circulatory damage (arterial ischaemia) is an important factor in delayed union.
3. Accurate reduction promotes better circulation and shortens convalescence.
4. Fixation must be adequate to control movements at fracture site, and must be maintained until union is firm.
5. Proper protection for function must be arranged during convalescence.

The author advocates the application of walking plaster next to the skin, after the method of Böhler, to hasten union and to bring about the return of function.—
F. G. Hodgson, M.D., Atlanta, Georgia.

OBLITERATIVE ENDARTERITIS IN WOMEN. N. Kukin. *Soviet Surg.*, VI, 40, 1934.

The author describes two cases observed in women. From a review of the literature and from personal experience, he concludes that this affliction has a milder course in women and is, therefore, frequently overlooked.—*Emanuel Kaplan, M.D., New York, N. Y.*

ÜBER ANPASSUNGSVORGÄNGE DES KNORPEL- UND KNOCHENGEWEBES IM VERSTEIFTEN GELENK (Compensatory Changes of Cartilaginous and Osseous Tissue in Ankylosed Joints). S. Milton Rabson. *Virchow's Arch. f. Path. Anat.*, CCXCI, 624, 1933.

The internal construction of the bony framework has a remarkable inherent ability to undergo changes to accommodate pathological conditions which change its lines of stress and strain. According to Roux, a continuous stress is responsible for the maintenance of normal bony construction.

By means of experiments, the author demonstrates various structural changes in bones in response to altered stress in pathological conditions. Since inflammatory conditions themselves produce atrophic changes during the process of ankylosis, the actual cartilaginous and osseous atrophy of disuse were determined by the author after amputation of the lower leg, due to gangrene of the foot; the cartilage and synovia were thus left intact over the articular surfaces of the patella and femur. Due to an intercurrent disease, the patient died some two and a half years later. At autopsy these articular surfaces revealed an entire absence of cartilage except for two small peripheral island with the remaining portions covered by pannus and fatty infiltration. Closer examination showed an irregular, calcified zone covering the diaphysis, with uneven haversian canals, etc. The pannus, composed of progressive but incomplete calcification among connective-tissue proliferations, extended to the diaphyseal ossification and united with it. Some areas presented an osseous surface, rather porous but continuous with the underlying diaphysis.

The author concludes from his experiments that in all ankylosed joints the intervening cartilage disappears in time. However, when the joint begins to function again, the epiphyseal cartilage is regenerated about the remaining cartilaginous "rests", or new cartilage may form over the functioning articular surface.—*Paul H. Rempel, M.D., Oklahoma City, Oklahoma.*